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**MARSHALL SPACE FLIGHT CENTER  
SOLID WASTE CHARACTERIZATION  
AND  
RECYCLING IMPROVEMENT STUDY**

(NASA-CR-199453) MARSHALL SPACE  
FLIGHT CENTER SOLID WASTE  
CHARACTERIZATION AND RECYCLING  
IMPROVEMENT STUDY: GENERAL OFFICE  
AND LABORATORY WASTE, SCRAP METAL,  
OFFICE AND FLIGHT SURPLUS Final  
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**MARSHALL SPACE FLIGHT CENTER  
SOLID WASTE CHARACTERIZATION  
AND  
RECYCLING IMPROVEMENT STUDY**

**General Office and Laboratory Waste  
Scrap Metal  
Office and Flight Surplus**

**Prepared for:**

**Facilities Office  
Marshall Space Flight Center  
Huntsville, Alabama  
Contract No. NAS8-38609, D.O. #121**

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## **ACRONYMS**

<b>ADEM</b>	<b>ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT</b>
<b>ASTM</b>	<b>AMERICAN SOCIETY FOR TESTING AND MATERIALS</b>
<b>BFI</b>	<b>BROWNING-FERRIS INDUSTRIES</b>
<b>C&amp;D</b>	<b>CONSTRUCTION AND DEMOLITION</b>
<b>COTR</b>	<b>CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE</b>
<b>CSI</b>	<b>CRABTREE &amp; SON, INCORPORATED</b>
<b>DRMO</b>	<b>DEFENSE REUTILIZATION AND MARKETING OFFICE</b>
<b>EPA</b>	<b>ENVIRONMENTAL PROTECTION AGENCY</b>
<b>GSA</b>	<b>GENERAL SERVICES ADMINISTRATION</b>
<b>IPC</b>	<b>INTERMEDIATE PROCESSING CENTER</b>
<b>HDPE</b>	<b>HIGH-DENSITY POLYETHYLENE</b>
<b>LDPE</b>	<b>LOW-DENSITY POLYETHYLENE</b>
<b>MDI</b>	<b>MARK DUNNING INDUSTRIES</b>
<b>MRF</b>	<b>MATERIALS RECOVERY FACILITY</b>
<b>MSFC</b>	<b>MARSHALL SPACE FLIGHT CENTER</b>
<b>MSW</b>	<b>MUNICIPAL SOLID WASTE</b>
<b>MWPF</b>	<b>MIXED WASTE PROCESSING CENTER</b>
<b>NASA</b>	<b>NATIONAL AERONAUTICAL AND SPACE ADMINISTRATION</b>
<b>OCC</b>	<b>OLD CORRUGATED CONTAINERS</b>
<b>ONP</b>	<b>OLD NEWSPAPER</b>
<b>OWP</b>	<b>OFFICE WASTE PAPER</b>
<b>PET</b>	<b>POLYETHYLENE TEREPHTHALATE</b>
<b>PVC</b>	<b>POLYVINYL CHLORIDE</b>
<b>PP</b>	<b>POLYPROPYLENE</b>
<b>RCRA</b>	<b>RESOURCE CONSERVATION AND RECOVERY ACT</b>
<b>RSA</b>	<b>REDSTONE ARSENAL</b>
<b>SWDA</b>	<b>SOLID WASTE DISPOSAL AUTHORITY</b>
<b>UBC</b>	<b>USED BEVERAGE CAN</b>

**Note:** Literature references listed in Section 7 of this report are indicated by a number in brackets in the text; example [35] ..., see Section 7, page 108 for complete citation.

## Executive Summary

George C. Marshall Space Flight Center (MSFC) issued a delivery order to The University of Alabama in Huntsville (UAH). The primary objectives of the study were to characterize the solid waste stream for MSFC facilities in Huntsville, Alabama, and to evaluate their present recycling program. The purpose of the study was to determine if improvements could be made in terms of increasing quantities of the present commodities collected, adding more recyclables to the program, streamlining or improving operational efficiency.

In conducting the study, various elements were implemented. These included sampling and sorting representative samples of the waste stream, visual inspecting each refuse bin, recycle bin, and roll-off, interviewing employees and recycling coordinators of other companies, touring local material recycling facilities, contacting experts in the field and performing a literature search.

A field investigation and visual inspections of waste and recycle bins revealed a number of inconsistencies or differences between a list provided by MSFC and actual findings. These differences included bins in different locations and sizes, missing bins, and buildings with refuse bins that were not included on the listing. The visual sort revealed somewhat large quantities of relatively homogenous materials. Those categories present in the largest quantity, by volume, were found to be corrugated cardboard boxes, restroom paper towels, and food and drink waste.

Six bins were selected as being typical of MSFC waste streams. These bins were hand sorted into fifteen categories and represented about 17 percent of the trash collected for any one day at MSFC. Building 4203 bin, containing the largest square footage of office space, had the largest weight percentage of white paper (37.4 percent) of the six buildings. Building 4471, which houses a receiving area for MSFC contained 31 weight percent corrugated cardboard. From the composition of these bins, potential recyclable quantities were computed indicating that white ledger paper could be increased from 401 to 724 tons per annum, aluminum cans from 9.5 to 23.5 tons per annum, and corrugated cardboard from 39 to 143 tons per annum. In addition, it appears that there are about 54 tons of newspaper available for recycling, plus about 50 tons of restroom towels and 26 tons of shredded paper available for recycling or composting. In addition, there are other commodities listed in the report for which there are known markets, but these commodities may be present in quantities too small to warrant addition to the recycling program at this time. Preliminary data indicate that MSFC should consider an on-site center for processing their recyclables.

The report includes a number of ideas and suggestions for possible improvement of the present recycling program at MSFC. Also included are program evaluations by twenty randomly selected MSFC personnel and descriptions of recycling programs at a number of private companies or public agencies.

## **Section 1**

### **Introduction**

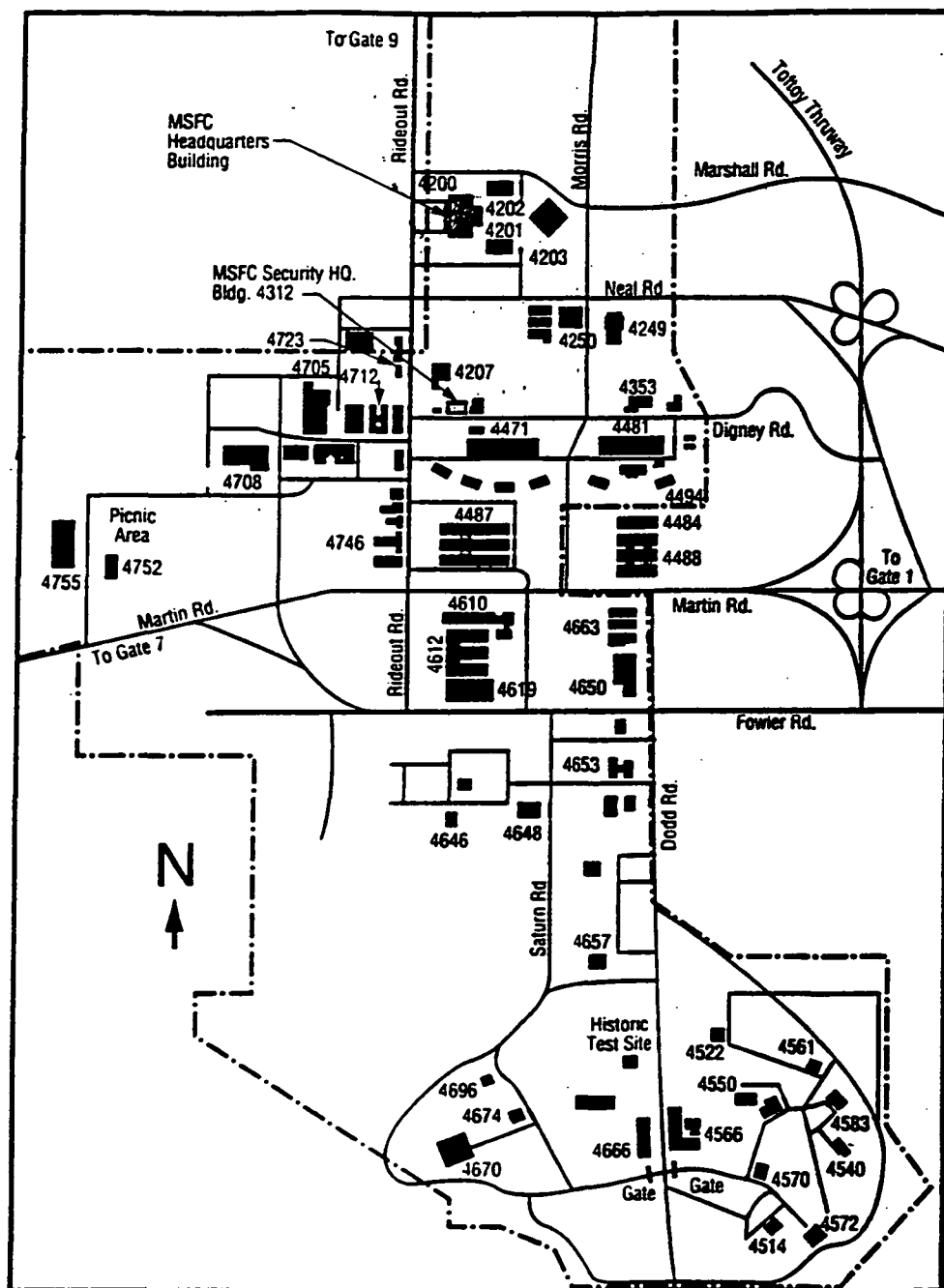
#### **Purpose of the Study**

On November 1989, a pilot recycling program for white paper was initiated in four George C. Marshall Space Flight Center (MSFC) buildings. (See Figure 1) From November 1989 until June 1991, 236 tons of white paper were collected. In July of 1991, a center-wide program to recycle white paper or ledger, aluminum cans or used beverage cans (UBC), and old corrugated containers (OCC) was implemented. From July 1991 until September 1994, 1,304 tons of white ledger, 20.5 tons of UBC, and 85.6 tons of OCC were collected for recycling. After the program started, additional commodities were added. Presently MSFC's interest is in formulating new approaches--to increase recycling, in a cost effective manner, and to divert more waste from their solid waste stream per Executive Order 12780, and in the interest of promoting good business practices. (Note: Executive Order 12780 has been superseded by Executive Order 12873.)

The MSFC Facilities Office, which is responsible for disposing of all waste generated by MSFC, issued a delivery order to the University of Alabama in Huntsville (UAH) to characterize current MSFC waste streams and to evaluate their existing recycling program. (Re: Contract DO #121, NAS8-38609, with Attachment 1.) The results of the work performed per the delivery order are contained herein. A purchase order was also issued to UAH requesting that the MSFC yard/wood waste and food service waste also be analyzed. These latter results are contained in a separate report.

The purpose of the study was to define the nature, quantity, and types of waste produced and to generate ideas for improving the present recycling program. Specifically, the following tasks were to be performed:

1. Identify various surplus and waste materials--as identified by the Contracting Officer's Technical Representative (COTR), Mr. Cedreck Davis--by source, location, and type.
2. Analyze MSFC's current methods for handling, storage, transport, and disposition of waste and surplus materials.
3. Determine the composition of various surplus and waste materials as to type and quantities from various sources and locations.
4. Analyze different methods for the disposition of various surplus and waste materials, including quality, quantity, preparation, transport cost, and value.



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Figure 1. MSFC Redstone Arsenal Facility

5. Study possible alternatives to current methods of handling, storage, transport, and disposition of surplus and waste materials to improve the quality and quantities recycled or sold and to reduce and minimize the quantities of surplus and waste material currently being disposed of or stored.
6. Provide recommendations for source and centralized segregation and aggregation of materials for recycling and/or disposition.
7. The analysis could include identification and laboratory level evaluation of methods and/or equipment, including capital costs, operating costs, maintenance requirements, life cycle and return on investment for systems to support the waste reduction program mission.

The specific waste and surplus materials identified by the COTR for study included general office and laboratory waste, excess "flight" hardware, and scrap metal. MSFC currently has a program in place for recycling white ledger paper, laser printer cartridges, telephone books, corrugated cardboard, aluminum cans, grass and leaves, wood waste, scrap metal, electrical wire, tires, waste cooking oil, used motor oil, and used lead batteries. As these items are presently being recycled, the objective here was to analyze the present system to determine ways to improve project participation and to streamline and economize on operations. In addition, analyses was made of the solid waste stream to determine if additional items or components presently being disposed of at the RSA inert landfill, the Huntsville landfill, and the Huntsville incinerator could be recycled.

Those individuals who participated in performing the analyses and preparing the report included Mr. James Colebaugh, Ms. Lavonne Crews, Dr. Michael Eley, Mr. Ben Johnston, and Mr. David Lee.

#### Elements of the Study

Specifically, the study was to look at ways to improve the quality and quantity of present recyclables and to, concurrently, reduce the amount of solid waste disposed of at the RSA and Huntsville landfills and the Huntsville incinerator. The elements incorporated to do this are described below. (Note: Refer to subsequent sections in the report for more detailed information.):

1. **Analysis of Waste Stream.** In order to determine, as closely as possible, the composition of waste generated, various analyses were performed. Initially each bin was inspected visually. A volume percentage of ten components was recorded as well as percent full for each bin. Next, six bins were selected based on high volume and what was considered to be a representative sample of typical waste generated. The trash from these six bins was sorted manually by project participants with a weight obtained for each of fifteen components. These same six bins were reinspected visually at a later date and the visual and manual results compared. Available total

and individual tonnage were obtained from the MSFC COTR and from others involved in hauling and disposition of waste and recyclables.

The number of personnel per building at MSFC was compared to published literature giving expected generated waste. These comparisons along with the findings and quantification of the waste stream are included in Section 3 of this report.

2. Meetings were held with those individuals involved in recycling and waste handling to discuss the functions and methodology of their operations. This included trash and recycling hauling, housekeeping, and disposal of excess equipment and supplies.

In addition, the housekeeping operations of three employees were observed in the performance of their duties. A tour was made of Building 8025 and the adjoining fenced area containing MSFC surplus supplies, equipment, and furniture. An overview of current waste/recycling handling is included in Section 2 of this report.

3. Tours were made of three local material recycling facilities (MRF's): BFI, South Central Recycling, and Huntsville Recycled Fiber. Information on operations and equipment was obtained from these private, profit making centers with the idea that a possible on-site center would be similarly staffed and equipped. Buyers of recycled and scrap materials were contacted to obtain current prices and quality used in the on-site feasibility study. The results of the tours and conversations along with costing information is provided in Section 5 of the report.
4. A face-to-face employee survey was performed to evaluate the effectiveness of the current recycling program and to garner suggestions for improvement. Twenty employees located in nine separate buildings were questioned. A summary of the findings is contained in Section 4 of the report with the actual surveys in Appendix A.
5. The recycling coordinators of ten private companies and public institutions were contacted to discuss the elements and successes of their respective programs. A summary of the findings, with emphasis on those elements that appear to be adaptable to MSFC, is included in Section 4 of the report with the complete content of the surveys in Appendix B.
6. A literature review of waste handling and recycling was performed. As this field has undergone significant changes in recent years, few references dated prior to 1990 were consulted. Local and out-of-town experts were contacted for specific information. The books, articles and communiques from which sections of the report were generated are contained in the "References" section of the report.



## **State of Solid Waste and Recycling**

### **Municipal Solid Waste in the United States**

There were 20,000 active landfills in the U.S. in 1978, but by 1991, the number of landfills had decreased to 600 [81]. An additional 900 landfills were closed by 1993 [88]. Prior to implementation of 40 CFR 257 and 258 (containing new design criteria for landfills of solid municipal waste) with an effective date of October 9, 1993, there were over 90 landfills in Alabama. Presently there are 27. When state laws restricting vertical expansion of landfills become effective on October 9, 1995, it is anticipated that an additional five or six landfills will close. (Note: The Huntsville landfill is in full compliance with the federal and state regulations. The existing landfill was expanded to include lined cells with leachate collection system.) [94]

In 1960, annual solid waste generation in the U.S. was an estimated 82 million tons. [18] In 1990, Americans generated 195 million tons of municipal solid waste ( 4.3 pounds per person per day), an eight percent increase over 1988. [87] In 1992, 87 million tons of commercial trash were produced in the United States [19] Consumer trash for the same year was 116 million tons [19] for a total of 203 million tons. Without additional source reduction, the amount of waste generated in 1995 is expected to reach 208 million tons. By the year 2000, this figure is projected to reach 222 million tons, or 4.5 pounds per person per day.[14]

In 1990, offices in the United States generated 15.5 million tons of waste (excluding restroom and cafeteria waste). This consisted of [13]:

- Printing/Writing Paper - 8.1 million tons
- Old Corrugated Containers - 1.2 million tons
- Old Newspapers - 1.6 million tons
- Other (glass, metals, plastics, general trash) - 4.6 million tons.

By 1995, this figure is estimated to reach 17.8 million tons. [13]

### **Recycling in the United States**

The national recycling rate in 1988 was 13 percent (with 73 percent of all municipal solid wastes landfilled). [87] The amount of yard debris that was collected for composting was 2 percent in 1988. [87] For 1990, figures show that 17 percent of our solid waste was recovered for recycling with 12 percent composted (67 percent ending up in landfills with about 16 percent incinerated). [14, 82, 87] In 1993, the national recycling rate reached 19 percent. [88]

In 1992, commercial recycling totaled 22.9 million tons. Curbside collection accounted for 5.1 million tons and consumer drop-offs, buybacks, and paper drives 8.3 million tons. [19]

EPA projects that while the amount of waste generated in the U.S. will continue to increase during the 90's, it will do so at a slower rate. Per capita waste generation is expected to reach 4.5 pounds per person by 2000. EPA also projects recycling scenarios of 20 -30 percent in 1995 and 25-35 percent in 2000. [87] This plus composting is estimated to reduce the per capita generation of MSW from 4.5 to 3.5 pounds per person per day. [14]

### Municipal Solid Waste and Recycling in the State and Locally

In a 1993 survey, Alabama generated 5,200,000 tons of municipal solid waste, recycled 12 percent, incinerated 8 percent and landfilled 80 percent. [82, 88 ] In addition, the survey indicated that Alabama had 30 curbside programs serving 656,000 people, 12 MRF's taking in commingled recyclables with one mixed waste MRF, and 12 yard trimming composting programs. [88]

There is currently only one MSW incinerator in the state of Alabama--which is located on Triana Boulevard in Huntsville. It has a current tipping fee of \$39.90 and a capacity of 700 tons/day. The incinerator allows the Solid Waste Disposal Authority for the City of Huntsville and Madison County (SWDA) to reduce the volume requiring landfilling by 90 percent. The Huntsville landfill has a tipping fee of \$39.90 as well. [93]

The SWDA contracts with Browning-Ferris Industries (BFI) for the collection, processing, and marketing of recyclable commodities. The recycling program consists of a curbside collection system serving 50,000 single family homes in Huntsville and 17,000 homes in Madison County. The program also includes six unmanned drop-off sites. For this service, BFI receives \$1.45 per home per month for Huntsville residences, \$1.70 per home for Madison County residences, and \$300 per drop-off center per month. In addition, BFI retains revenues from the sale of all materials collected. [93]

### **General Information, Trends, and Projections**

#### Waste Paper

Waste paper is bought and sold on the basis of grade, as generally defined by the Paper Stock Institute of America (an association representing waste paper dealers) varying from low grade such as newspaper to high grade such as computer paper. [69] The Paper Stock Institute lists 51 paper grades and also gives standards for maximum allowable prohibitive materials (unusable) and total outhrows (unsuitable). [18] Mixing different grades lowers the quality, with the secondary fiber dictating the grade into which the paper falls. Paper and paperboard products make up 32% of the discards to landfills by weight and by volume. [14] About 30 to 40 percent of the wastepaper stream is so mixed with nonpaper materials such as metal foils, household wastes, and plastics, that it cannot be economically recycled back into paper products. [78] It takes 50 percent less energy to remanufacture paper. [81]

## Office Paper

Office waste paper generally falls into two distinct categories: high quality such as white ledger and low quality such as mixed office paper. [69] It is estimated that the federal government purchases 300 million tons of paper per year or about 2 percent of the national paper market. [69]

In December 1992, recycled paper consumption totaled nearly 26.5 million tons, or 28.3 percent of all industry fiber in the country. In 1995, it is predicted that consumption of recovered paper at paper and paperboard mills should approach 31.5 million tons, or 32.8 percent of total fibers used. [73]

Office waste paper (OWP) is expected to be the commodity of the future. During 1995, eight new deinking mills, six new tissue mills, and 12 new market pulp mills are expected to come on-line creating one million tons of demand on the east coast. [46] Eventually the recovery rate for OWP is projected to reach 67 percent. [74] By 1998, another 56 paper recycling ventures--including 40 new or expanded deinking mills--are expected to come on-line. [75]

## Corrugated Cardboard

Old corrugated containers (OCC) represent the single largest category of waste paper collected for recycling. In the U.S., OCC comprises 40% of all waste paper recycled. [69]

Projected demand for OCC, based on present patterns (September 1994), are expected to exceed the economically available supply. To meet the increasing demand for OCC, recovery from all sources of supply will be increasing, specifically from small generators. [68] Currently mills are spending millions of dollars to retrofit their facilities in order to accept greater percentages of secondary fiber--corrugated cardboard. [69] The EPA has recommended that corrugated containers have 40 percent total recycled content, of which post-consumer materials must account for 35 percent, which will continue to spur demand. [69] The eventual recovery rate for OCC is projected at 70 percent. [74] Mead Corporation is planning on expanding their mill in Stevenson, AL in anticipation that demand for corrugating medium will grow 3 percent annually through 1993. [147]

## Newspaper

Over the next five years (1993-1998), it has been projected that old newspaper (ONP) demand will grow significantly as new or retrofitted mills come on line. [69] The eventual recovery rate for ONP is projected to reach 59 percent. [74]

## Magazines

Recovery of magazines lags behind other types of paper. It is estimated that magazines are recycled nationally at a rate of about 15 to 20 percent. In mid 1993, there were 20 mills consuming large amount of old magazines (OMG). (OMG consists of newsstand returns and postconsumer magazines.) It is estimated that by 1995, the number of OMG mills will increase to 30, and a recycling rate of 35 percent will be needed to meet this demand. [79]

The demand for magazines is predicted to increase as new newsprint facilities which utilize floating deinking technology come on-line. This new technology requires 20 to 50 percent coated magazine stock to aid in the process. [69] Indeed, a new \$40 million deinking facility in Claiborne, Alabama came on-line in the latter half of 1993. It processes approximately 160 tons per day of old newspapers and old magazines [72]

## Glass

The price paid for glass containers is generally determined by color, quality, and the extent to which it has been prepared (crushed or whole). The price is also influenced by the proximity to glass manufacturing facilities. The primary markets for recycled glass containers are the 75 glass container manufacturing plants in the U.S. Secondary markets include road construction, the fiberglass industry, and manufacturers of reflective paints, abrasives and foam glass.[69] It takes 30 percent less energy to remanufacture glass. [81]

The use of cullet (reclaimed ground glass) in the manufacture of glass has increase from 22 percent in 1988 to 31 percent in 1991. Thirty-five percent of all glass containers sold to American consumers were recycled in 1993. [75]

In 1993, the largest U.S. glass container manufacturer ceased processing cullet due to its unreliable delivery and varying quality. Cullet prices are headed down. This plus the labor intensive, time consuming and safety concerns of processing glass, has lead many communities and recyclers to consider removing glass collection from their programs. [5, 95, 69] An obvious problem worthy of further study is the economical recovery and recycling of glass at MSFC.

## Aluminum Cans

Recycled aluminum has been the highest-valued commodity of all the secondary materials. [69] Recycled aluminum takes 5% of the energy that producing virgin material from bauxite does. The aluminum can, commonly called UBC (used beverage can) dominates the beverage can market with an average share of over 95%. Alcoa Aluminum and Reynolds are the two largest recyclers of aluminum beverage cans and prefer to receive the cans loose and flattened. The recycling rate for aluminum beverage cans remained the highest for all types of packaging in 1993. In 1992, almost 68 percent of aluminum UBC's were recycled, totalling nearly 63 billion cans. [90] A 63.1 percent nationwide recycling rate was

reported for 1993. (This equates to a post-consumer rate of 51.6 percent.) The 1993 figure was the first decline in the number of cans collected since record keeping began in 1972. [74] In 1993, aluminum prices hit an all-time low. More than 400,000 tons of aluminum were imported to the U.S. from Russia in 1993. Adding to the fluctuating prices is the light weighting of the can. Currently 29.5 UBC's equal one pound of aluminum. Within the next five years, it is expected 32 cans will equal one pound of aluminum. [46]

About 80 percent of aluminum UBC's that are recycled pass through buy-back centers. Around 15 percent result from deposit laws, and the remaining 5 percent coming from curbside programs.

### Steel Cans/Scrap Metal

Two types of metals are commonly recycled as scrap: ferrous and nonferrous. Scrapped autos are a major source of ferrous scrap. A substantial portion of total tonnage of shredded ferrous scrap is exported. In 1992, the total scrap metal recycled in the United States consisted of 41,764 thousand metric tons (tmt) of iron and steel, 2,757 tmt of aluminum, 1,276 tmt of copper, 917 tmt of lead and 366 tmt of zinc. In 1992, the quantity of iron and steel recycled in the United States from purchased scrap nearly equaled that of all other materials combined (nonferrous metals, paper, glass, and plastics). The ratios of metal recovered from old scrap as a percent of apparent consumption for 1992 was 28 percent for aluminum, 24 percent for copper, 70 percent for lead, and 10 percent for zinc. [90] The steel industry currently has an overall recycling rate (including appliances, cans, cars, and industrial scrap ) of 66 percent. [71]

Ferrous cans are made up of three general types of containers: the tin-plated steel food container which is coated on the inside with a thin film of tin to preserve freshness of food, steel cans that do not have the tin plating, and a bimetal can that has a steel bottom and sides with an aluminum top. The steel industry prefers the tin-plated steel container after the tin and other contaminants are removed in a detinning facility. In the residential waste stream, the tin-plated steel food can is the largest volume ferrous metal product discarded. Presently, there is no economical way to separate the metal of the bimetal cans, resulting in little potential to recycle them. Steel producers lead the market for recyclable steel cans. This industry is in a slump due to the decrease in demand from auto makers who are tending to replace steel with plastics. [69] Another problem worthy of further study is the separation of bimetal can components.

In 1993, more than 34 billion steel cans were produced. Of that amount, almost half or 48 percent--more that 1.3 million tons--was recycled. There was an increase of 7 percent from 1992 to 1993. In most communities, 2-percent of municipal solid waste (MSW) by weight will consist of steel cans. Steel cans make up more than 90 percent of the food can market, and more than 100 million steel cans are used in the U. S. every day. The recycling rates in 1992 were 50 percent for steel beverage cans, 44 percent for food cans, and 15 percent for general line cans. [90]

The energy savings from using recycled metals compared with virgin materials is as follows: aluminum -95 percent; copper-85 percent; steel-74 percent; lead-65 percent; and zinc-60 percent. [90]

### Plastics

It takes 90 percent less energy to remanufacture plastics. [81] Plastics account for 10 percent by weight and 21 percent by volume of the discards to landfills.[14]

Today more than 200 different types of resins are used to produce plastic products within the United States. The five primary types, which compose roughly 98 percent of the plastic containers manufactured in the U.S. today (with the first three representing nearly 94 percent of the plastics market) are 1-PET-polyethylene terephthalate, 2-HDPE-high-density polyethylene, 3-PVC-polyvinyl chloride, 4-PP-polypropylene, 5-LDPE-low-density polyethylene. [69]. PET and HDPE are the two usually included in most recycling programs. For the most part, collected plastics are still manually sorted, also limiting the types collected.

Production of resin from post-consumer recycled plastic totaled 1.52 billion pounds in 1993, increasing 12 percent from 1992. [89] More than 50 percent of this amount consisted of PET and HDPE bottles.[70] PET is about 13 percent of all the rigid plastic packaging. HDPE is almost 70 percent. [85] It is projected that almost 1.9 billion pounds of virgin resin, or about 8 percent of the total forecast demand, will be displaced by recycled materials in 1998. [70] Beverage bottles make up 25 percent of plastics packaging, nonbeverage bottles, 25 percent, other rigid containers 30 percent, and film 20 percent.

The recycling rate for PET soda bottles was 41 percent in 1993. The 900 million pound demand for the bottles is twice that of current supply. Used soda bottles are being remanufactured into containers, carpeting, clothing, sleeping bags, athletic shoes, etc. Projections set PET demand at more than three times the current supply by the year 2000. [30] PET recyclers have depended primarily on the 10 states that require deposits on beverage containers for their supply of used PET drink bottles. [30]

### Historical Pricing Trends

Historical pricing trends of ONP, OCC, high grade office paper, glass containers, scrap metal, aluminum beverage cans, and HDPE plastic containers which have been paid by processors over the years are contained on the following figures (Figures 2-8). These figures were included to indicate the volatility of recyclable commodity prices and do not indicate absolute prices.

In addition, Figures 9-13 show national averages for 1993 for end users and processors for white ledger paper, ONP, OCC, PET and HDPE, aluminum beverage cans and steel food

cans have been included to indicate the relative difference between these two markets. Processors are dealers, brokers, and recycling centers. End users are manufacturers, mills, foundries and smelters. As can be seen from the figures, processors typically pay less than half and often only one third of current end user prices.

## **Legislation**

### **Recycling**

On October 31, 1991, President Bush signed Executive Order 12780 requiring Federal agencies to recycle materials from wastes generated by Federal Government activities (part 3, Section 301, refer to Appendix C). Federal regulation, 40 CFR 246 (in Appendix C) sets forth requirements and recommended procedures for source separation of recyclable commodities.

In Alabama, recycling is one of the industries targeted for financial incentives in the Alabama Development Office. Alabama gives tax incentives, grants and in 1993 passed legislation creating a task force to promote market development. [86] In 1989, Alabama set a 25 percent recycling/reduction goal with a legislated 1995 deadline. [18] ADEM compiles information of public schools, universities, and state agencies to track their recycling efforts. The exact percent recycled varies by commodity and the particular group involved. However, for all groups, office paper is the commodity with the highest recycling volume, ranging from 33.8 percent to 58.9 percent. [143]

### **Purchasing Recycled Products**

RCRA (Resource and Conservation Recovery Act), Subtitle F (Solid Waste Disposal Act Subchapter VI, Section 6962, see Appendix C) requires Federal agencies to give purchasing preference to products made from recycled materials. In 1993, President Clinton signed Executive Order 12873 (see Appendix C) requiring that each Executive agency incorporate recycling in daily operations and expand markets for recovered materials through procurement preference. Per Section 504 of the Order, the federal government, sets minimum postconsumer content standards for printing and writing paper.

### **Landfills**

In 1965, the Solid Waste Disposal Act was passed to improve solid waste disposal methods. It was amended in 1970 by the Resource Conservation and Recovery Act (RCRA), which was amended in 1980 and 1984. Subtitle D of RCRA gives standards for the safe operation of solid waste management facilities. Subtitle D also established a voluntary program in which states may develop and implement solid waste management plans, siting the federal standards as a minimum.

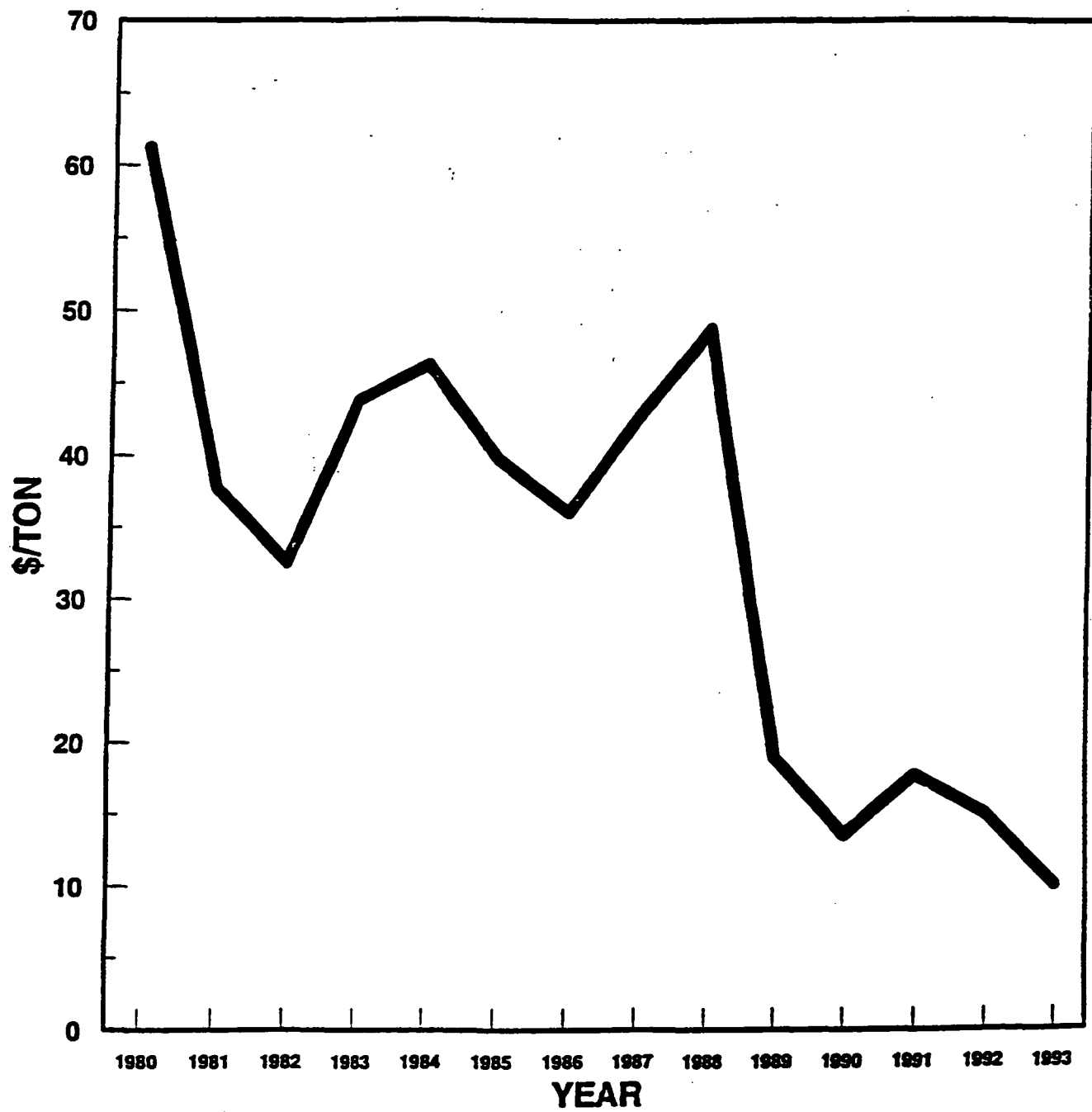


Figure 2. Pricing Trends for Old Newspaper [69]



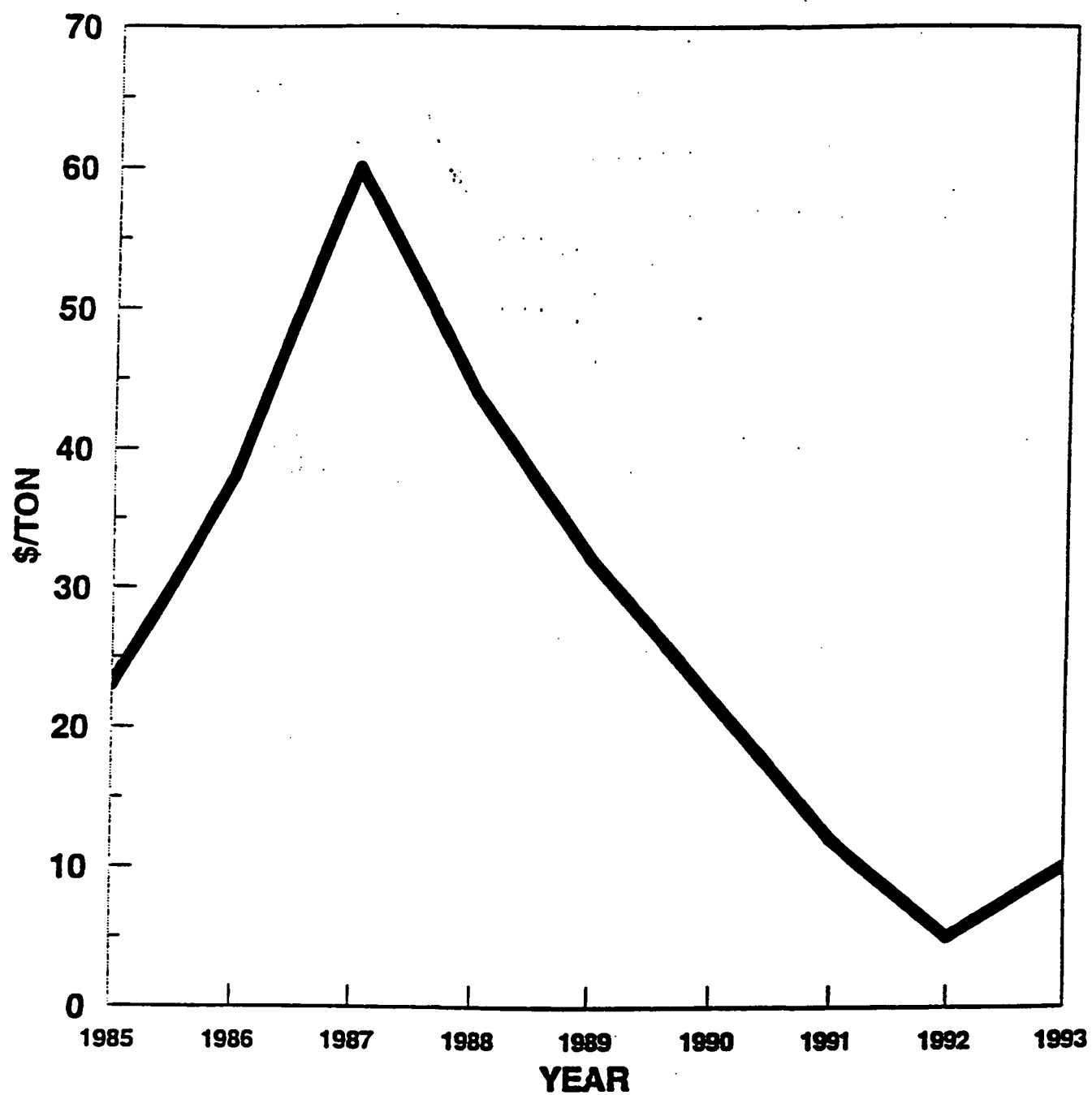


Figure 3. Pricing Trends for OCC [69]

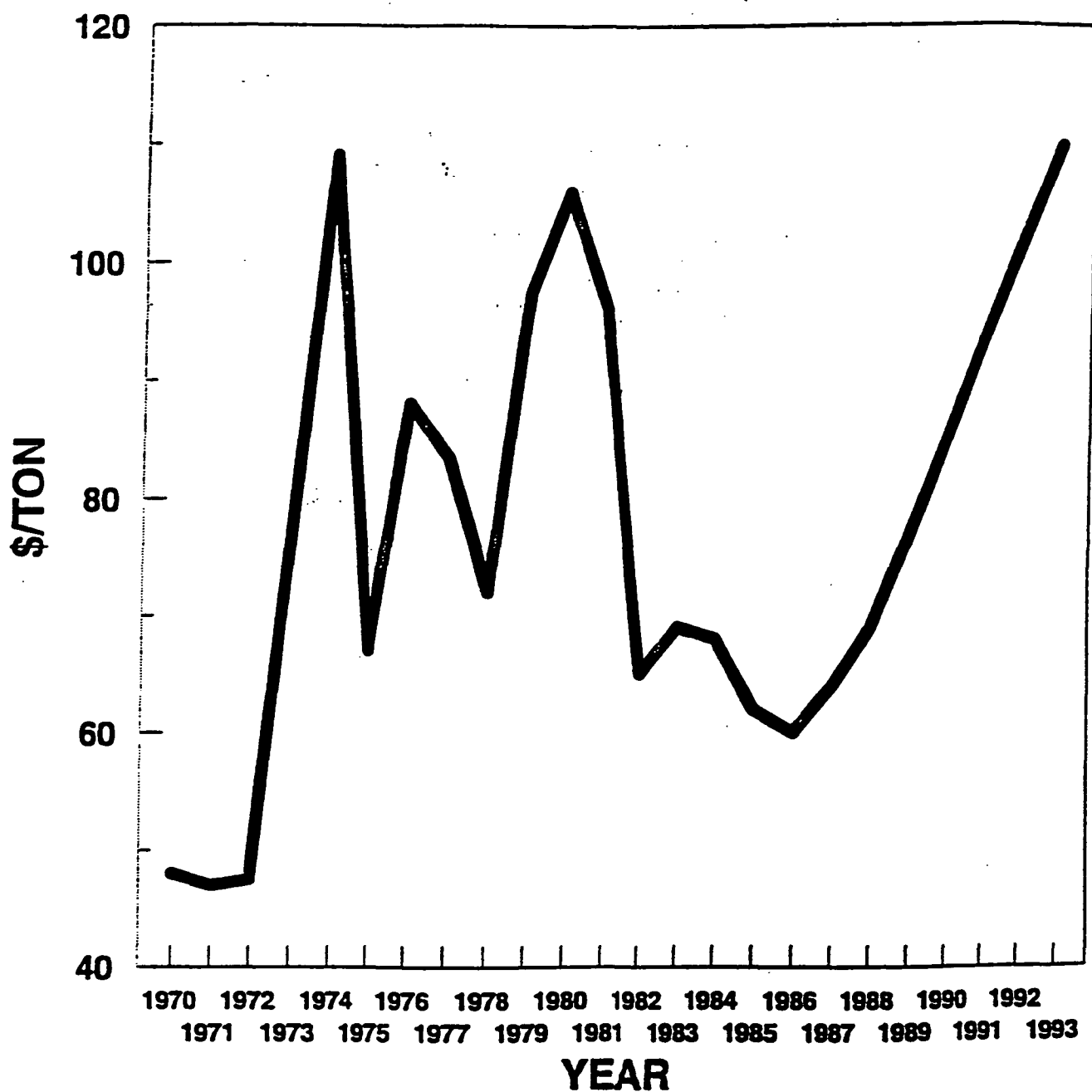


Figure 4. Pricing Trends for High Grade Office Paper [69]

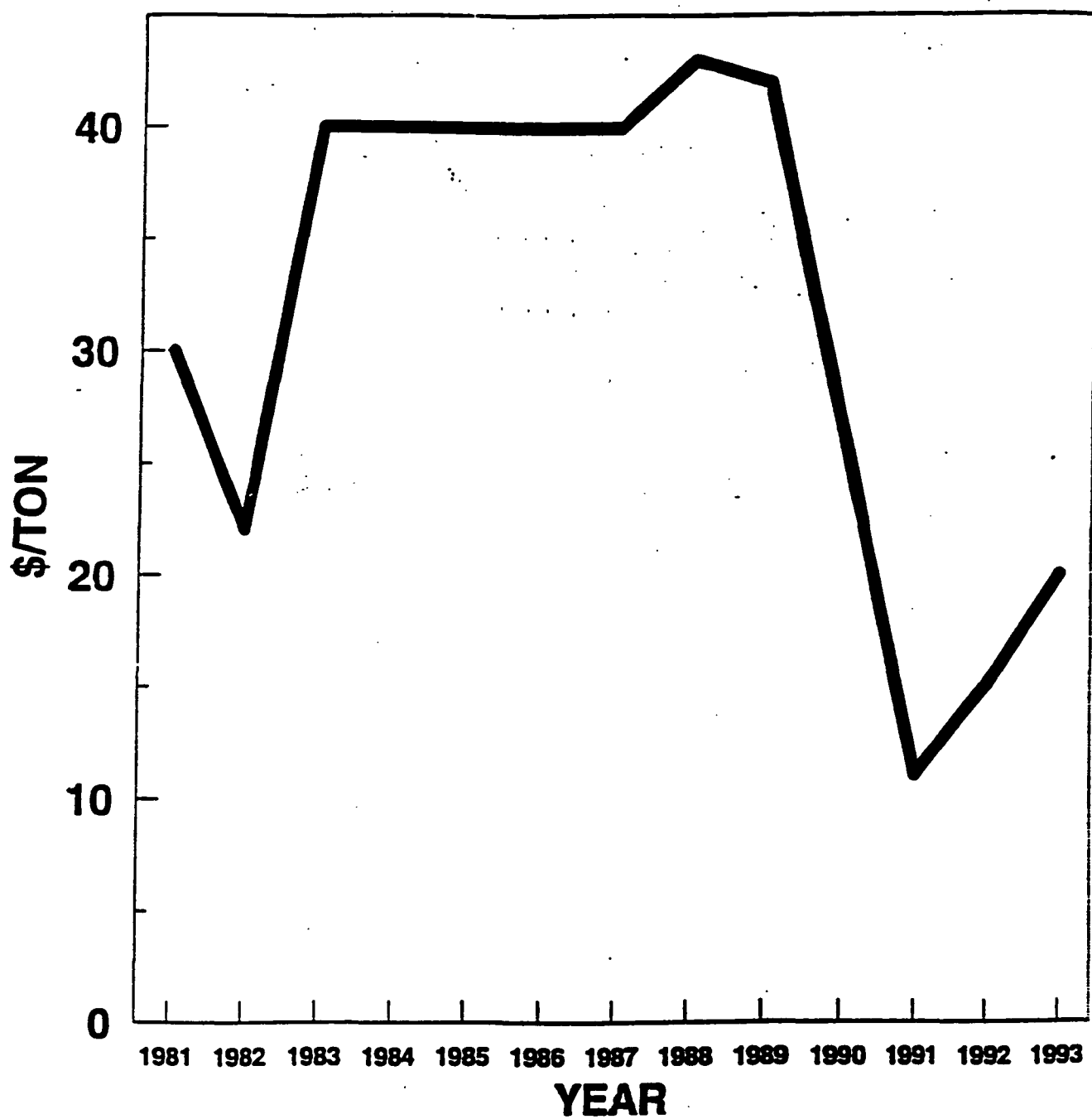


Figure 5. Pricing Trends for Glass Containers [69]

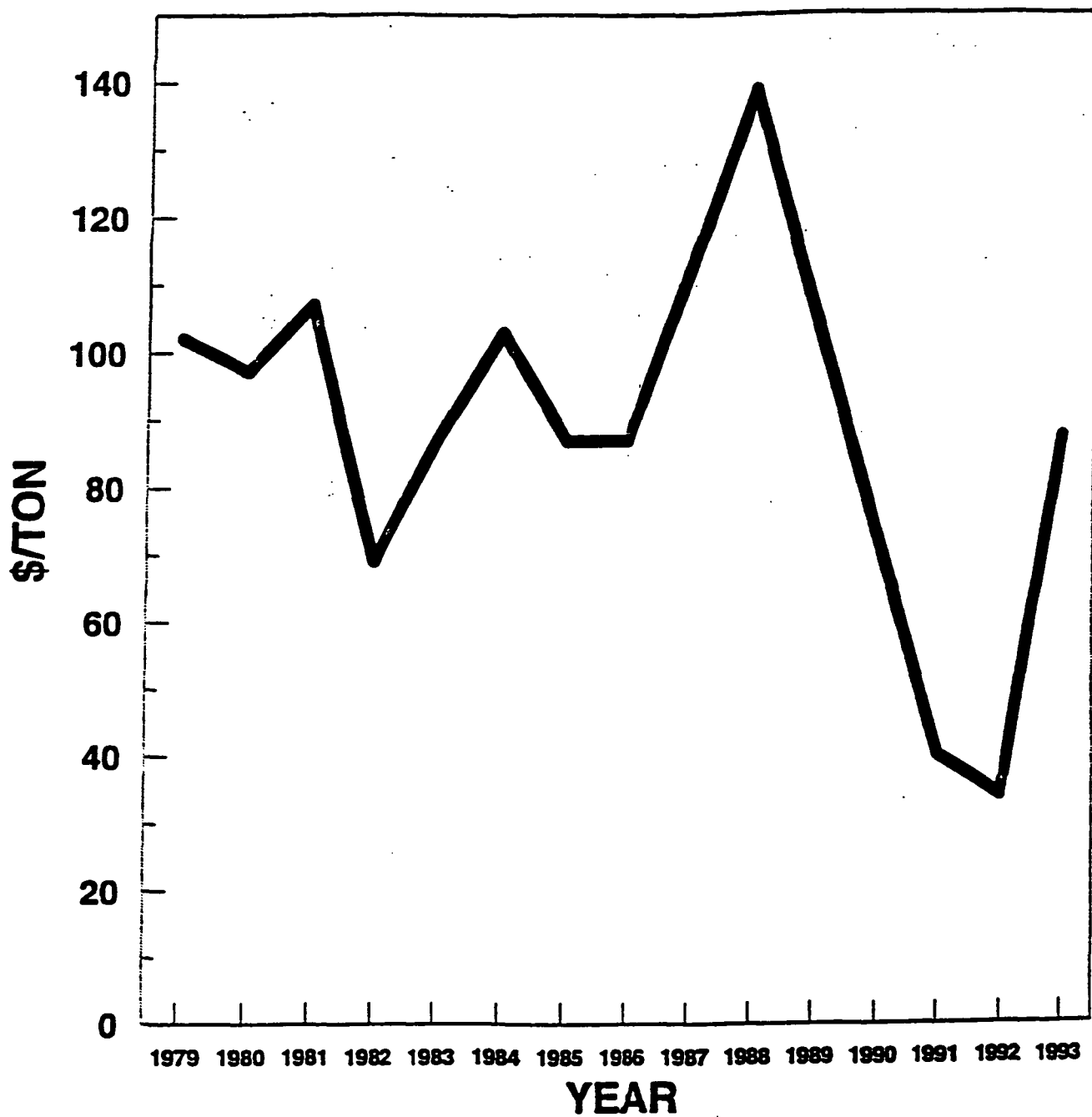


Figure 6. Pricing Trends for Scrap Metal [69]

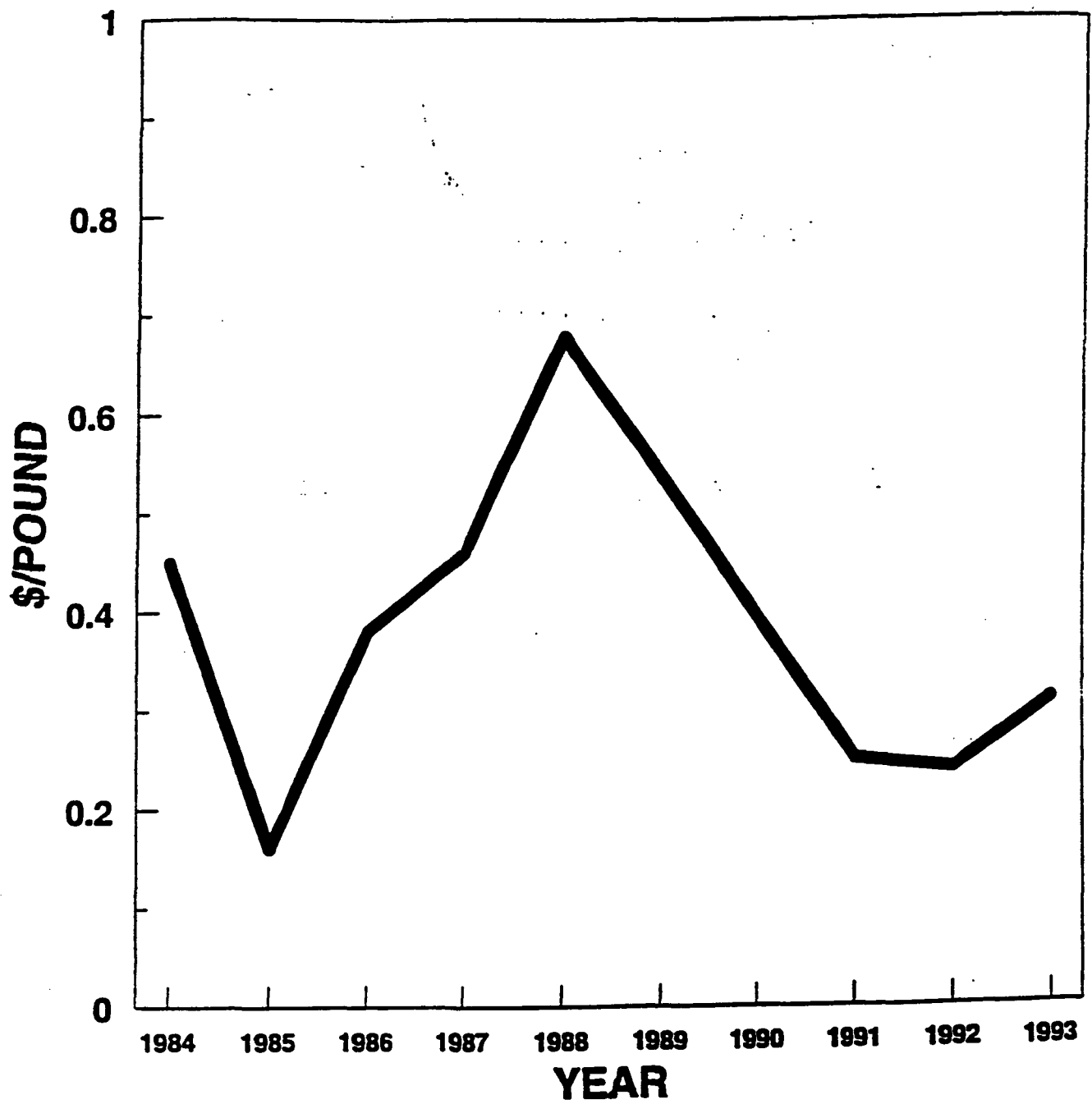


Figure 7. Pricing Trends for Aluminum UBC [69]

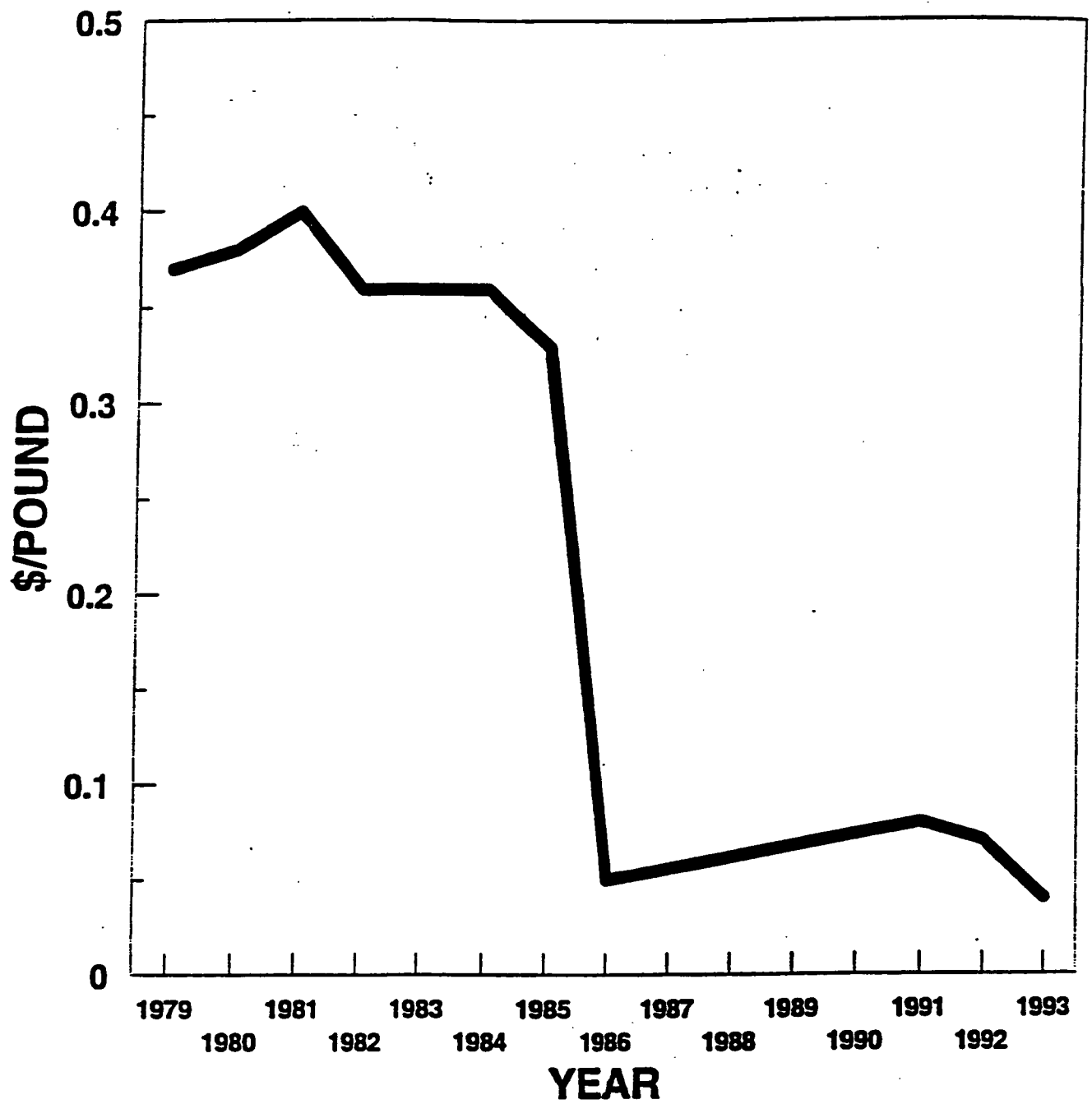


Figure 8. Pricing Trends for HDPE Plastic Containers [69]

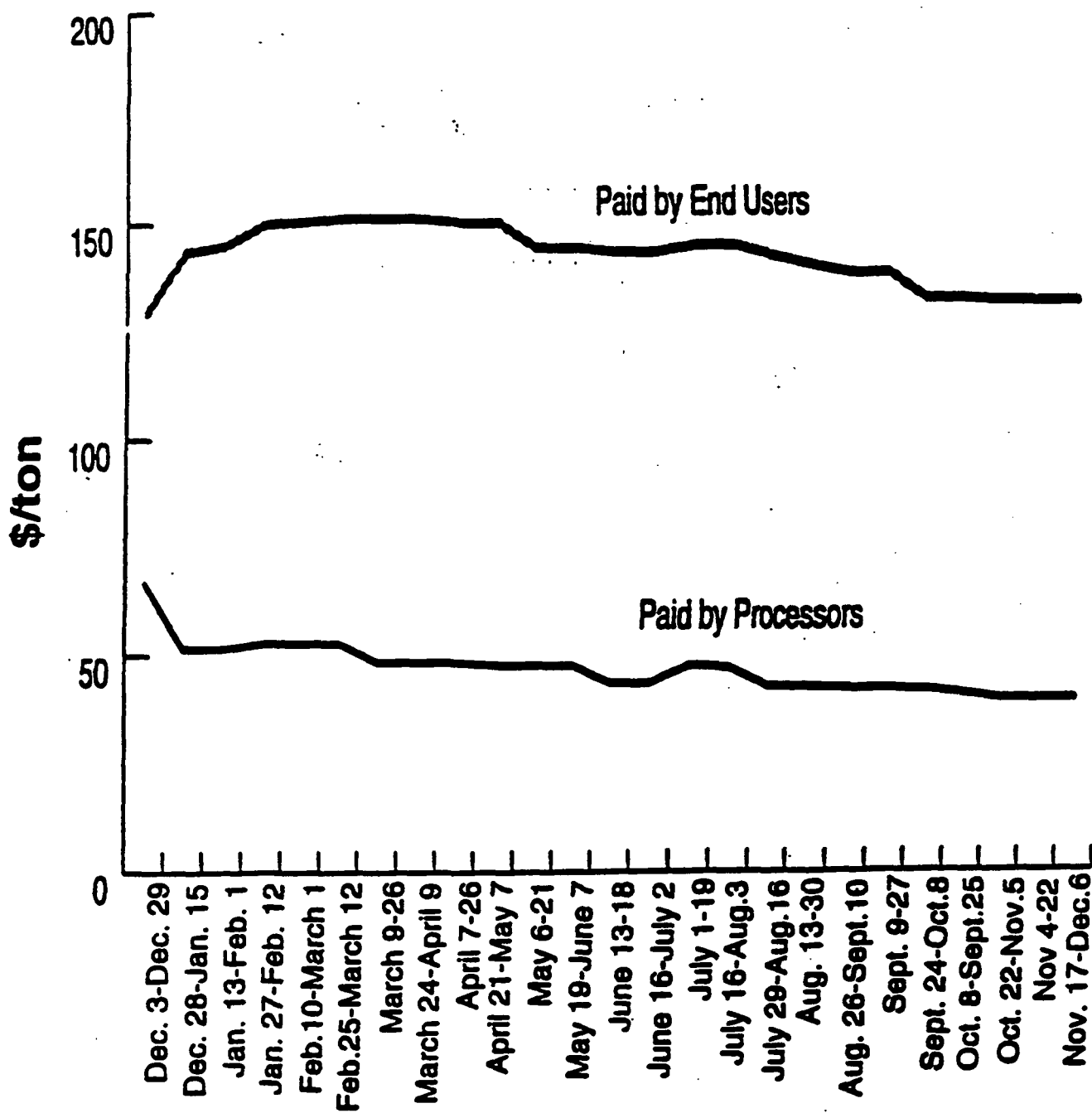


Figure 9. White Ledger Prices - National Averages - 1993 [102]

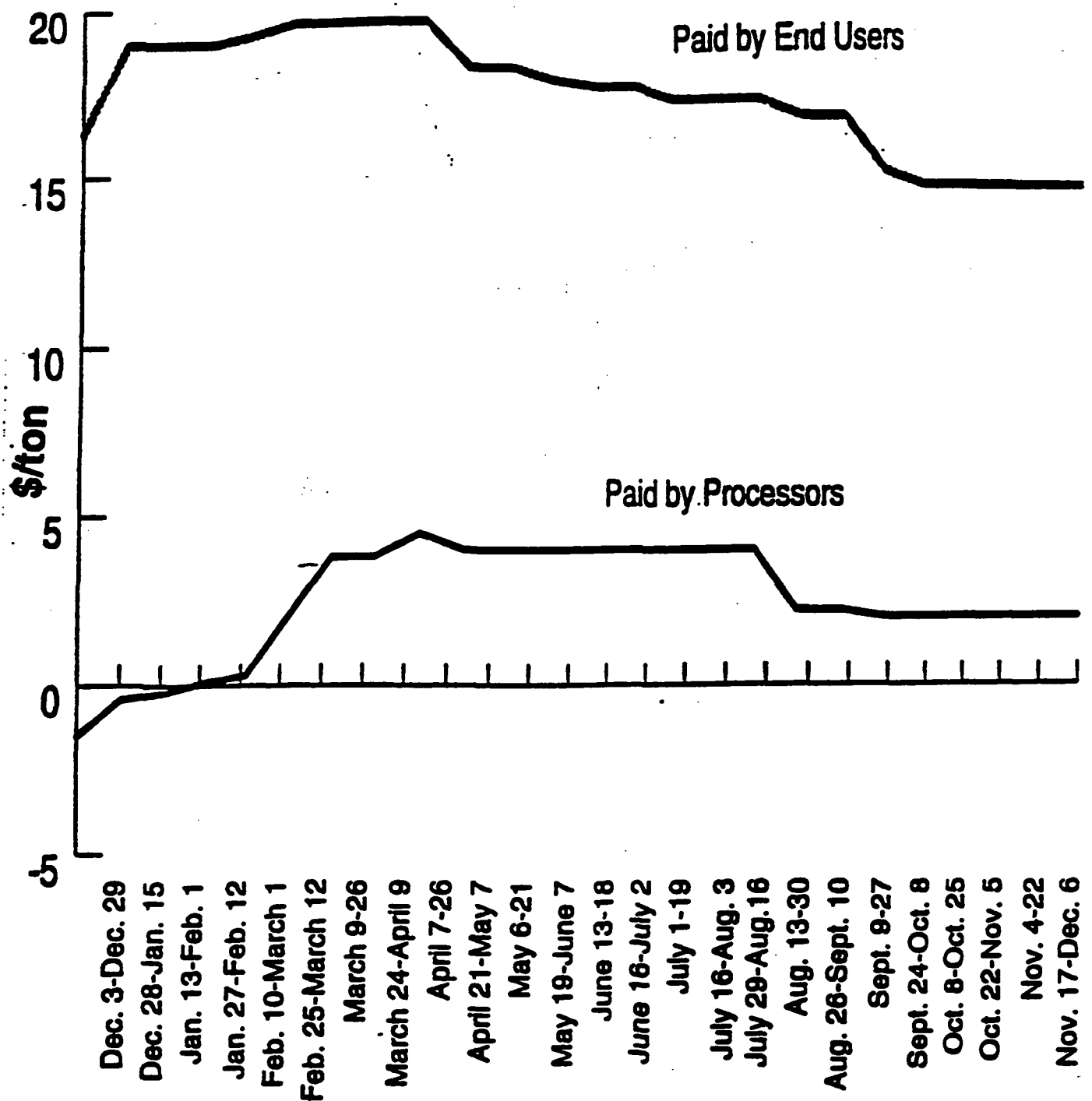


Figure 10. Old Newspaper Prices - National Averages - 1993 [102]



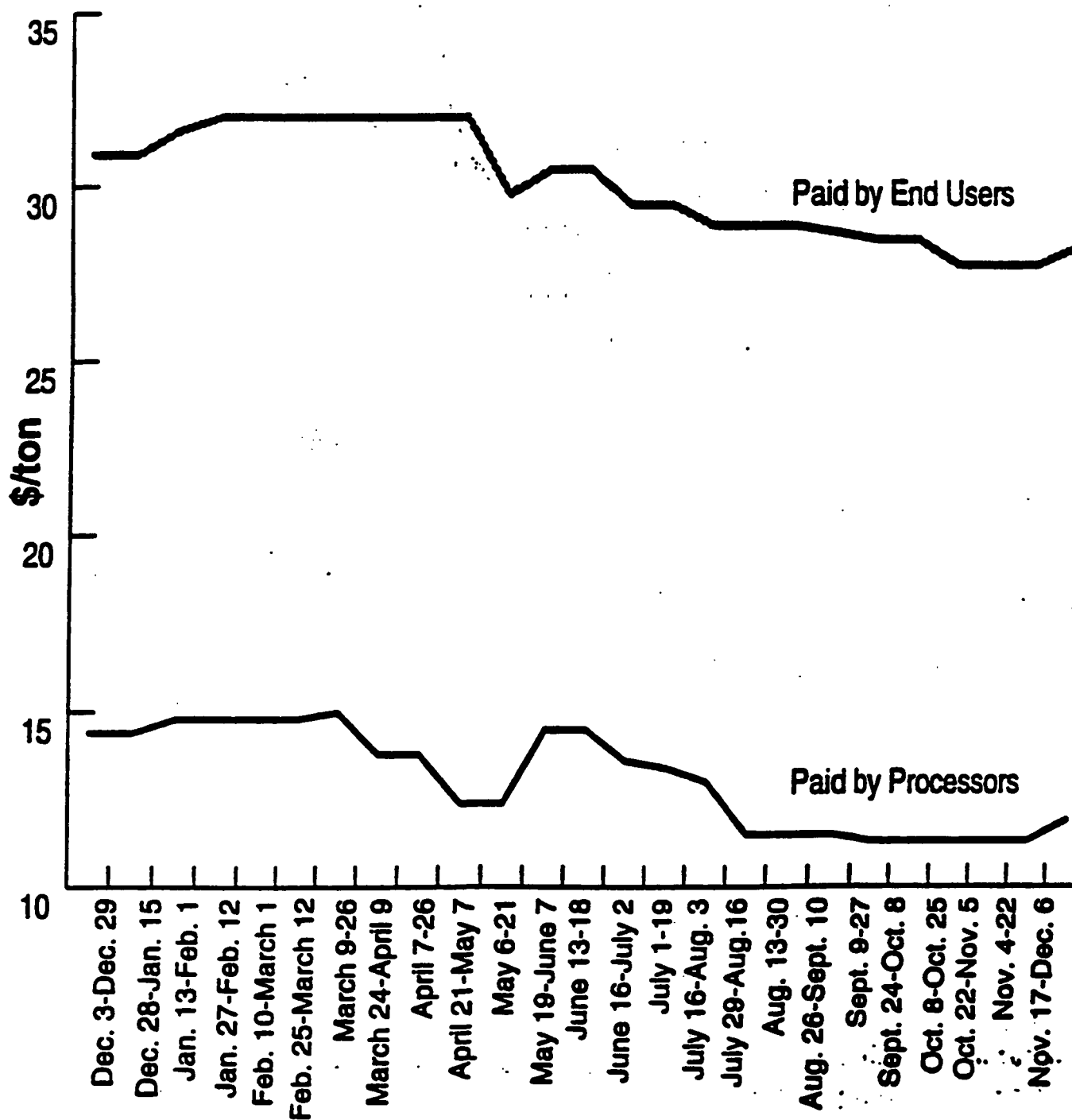


Figure 11. Old Corrugated Container Prices - National Averages - 1993 [102]

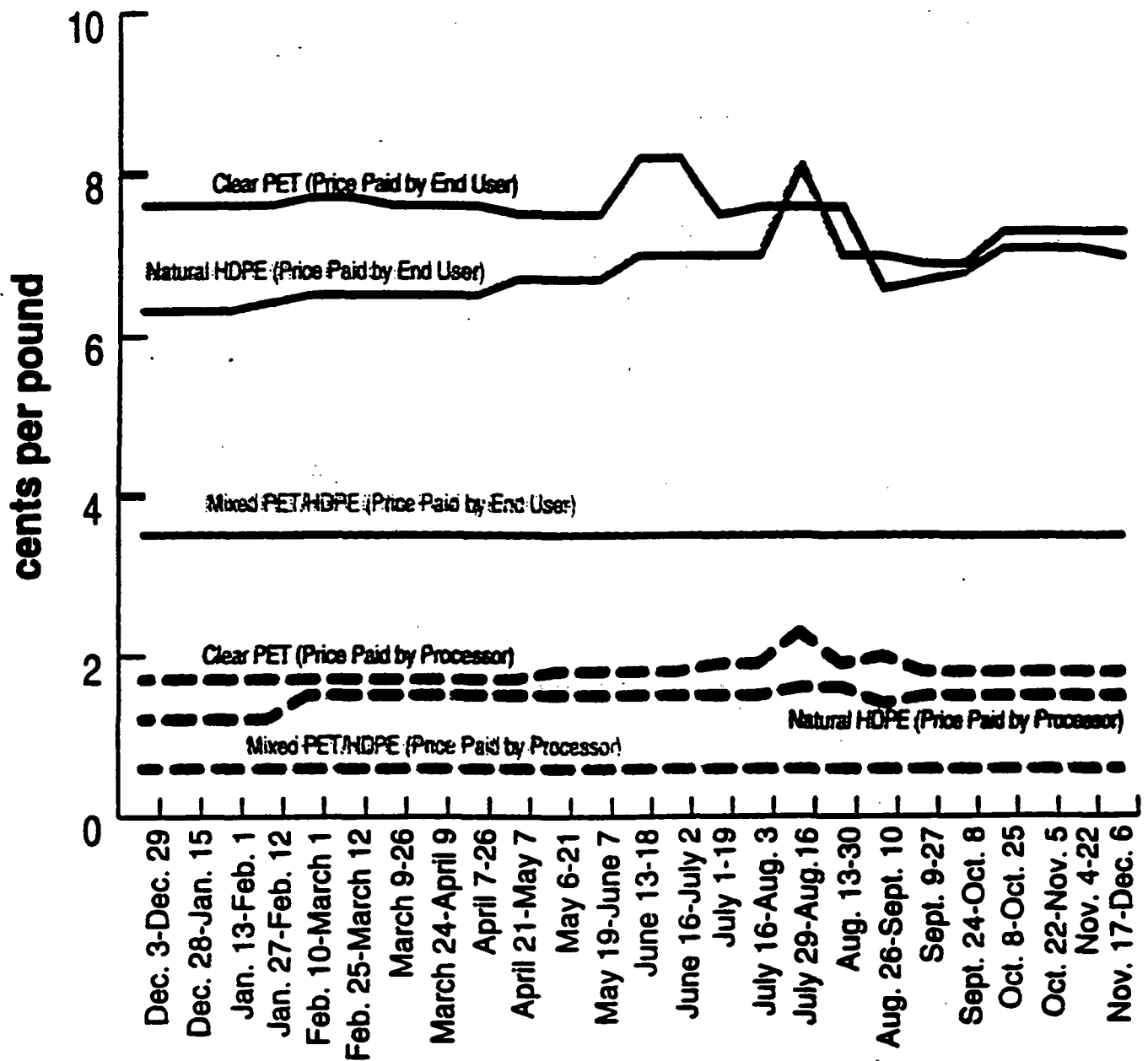


Figure 12. Plastic Container Prices - National Averages - 1993 [102]

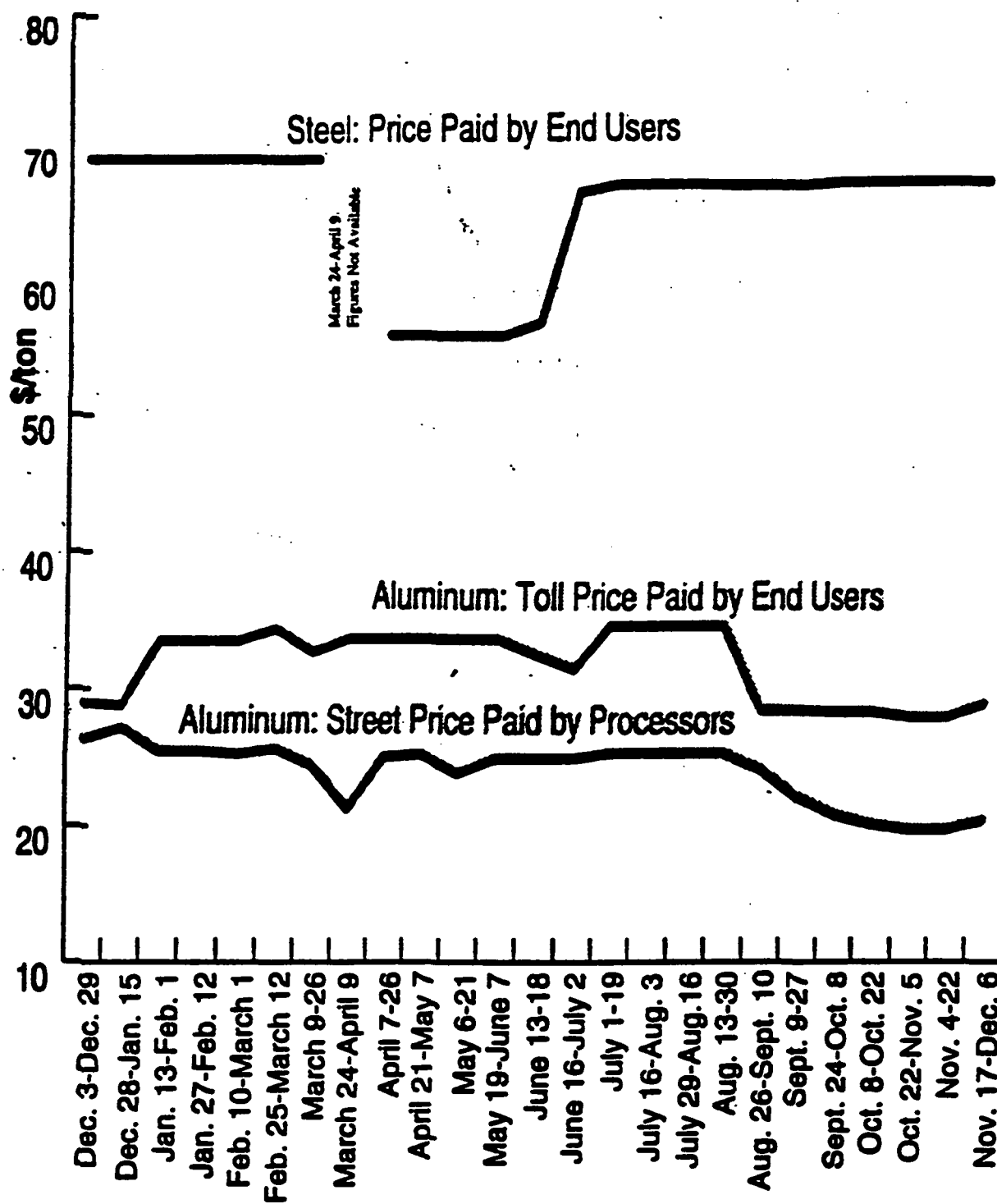


Figure 13. Aluminum UBC's and Steel Food Can Prices - National Averages - 1993 [102]

## **Section 2**

### **Background**

This section contains an overview of solid waste and recyclable handling methods currently in practice at MSFC. Estimated total quantities are contained in Section 3. Table 1, following the narrative, contains a complete bin listing.

#### **Current Solid Waste and Recyclables Contracts**

Browning-Ferris Industries (BFI) located on Commercial Drive in Huntsville presently has a contract with MSFC to collect their white ledger paper, aluminum cans, and cardboard for recycling. BFI pays MSFC a percentage of the market value received. Under the current contract, this percentage is: 25% for white ledger paper, 95% for cardboard, and for aluminum: American Metal Market's average street price plus \$.02/pound. [2]

The solid waste from the MSFC facilities is collected and hauled by Mr. Rick Hopkins of Mark Dunning Industries (MDI), who has an on-site office located in Building 4241. The U.S. Department of the Army located at the RSA has a contract with the Solid Waste Disposal Authority of the City of Huntsville and Madison County (SWDA) who operates the incinerator located on Triana Blvd. Per this contract, the army buys the steam generated by the incinerator. (The army is obligated to buy all steam generated, even that not used and vented to the atmosphere.) The army supplies MSFC with steam for building heat. As part of the contract with the city, the army is permitted to dispose of up to 50 tons of waste per day at the incinerator at no cost. The army presently generates between 30 and 38 tons per day of waste. [3] The MSFC facilities generate 5 to 6 tons per day of waste. [1] Thus, combined, the 50 ton per day limit is not reached. MSFC pays the army for its utilities, and waste disposal at the Huntsville incinerator is considered a part of the utility costs.

#### **Office and Laboratory Waste**

Each office employee is provided with two waste receptacles: one for depositing regular trash and the other for recyclable white ledger paper. The white paper bin is labeled with a list of acceptable items (computer paper, bond and copier paper, white paper with any color printing, white tablet paper, the company newsletter (Marshall Star), newsletters (if white), white stationary, white envelopes with no windows, plus post-it notes, routing slips, adding machine tape, and card stock, as long as these items are white. Paper clips and staples do not have to be removed but other clips/fasteners (alligator, bulldog, or binder type) are to be removed before depositing white paper in the receptacle. (It is doubtful that clips would be left on as most employees save and recycle these.) The label states that only 1% of non-white debris is allowed by recycling companies. Newer labels have a phone number listed if the employee has a question. The older labels and those on most of the current bins are missing this contact number. (However, a number is listed in the back

of the MSFC phone book under "Recycling.") Two sizes of the white paper recycling bins are available.

Each employee is responsible for taking his/her aluminum cans from soft and fruit drinks purchased from vending machines and cafeterias to special aluminum can receptacles. Normally these receptacles are located by the vending machines. Some, however, are located near elevators or in hallway corners. Some employees take their cans home where they collect and recycle them on their own.

Housekeeping employees (trashers) are responsible for emptying the receptacles from three times per week to a daily (Monday - Friday) frequency. Sometimes the same individual empties both the regular trash and the white paper bins, sometimes different individuals perform these functions. The larger buildings have segregated work; for the smaller buildings, the same personnel will collect trash, clean rest rooms, and mop/clean floors. Generally the trash and white paper are emptied into separate bins on a push cart(s) maneuvered office-to-office by the housekeeper assigned that particular building and/or floor. When these cart bins or bags are full, the housekeeper empties the contents into an outside refuse bin (trash) or into a larger container in the building (white paper). Each night, one individual collects the white paper from the buildings for deposit into the BFI recycle bins.

There are twelve 6 cubic yard and two 8 cubic yard gray recycle bins located at various MSFC buildings--locations as given on Table 1 and on Table 4--for the collection of white paper. The white paper is picked-up every Wednesday by BFI via a front-end loader. The truck, upon returning to the BFI facility located on Commercial Drive is weighed, first with its load of paper and then empty, on certified scales. BFI performs limited hand picking to remove obvious contaminants from the white paper prior to baling. The biggest problem BFI has encountered in the MSFC paper collection is mixing in of plastic material; such as overhead viewgraphs and drafting mylar and vellum. (Plastic material will plug the drains at the pulp mill causing a shutdown of operations, ultimately resulting in the mill refusing to accept any more paper from that dealer.) [5]

All "bin" trash is collected in a front-end loader vehicle and hauled by MDI to the Huntsville incinerator. Bin sizes and locations are listed on Table 1 and Table 2. Collection schedules vary from one to five days per week (Monday - Friday) depending on fill rate. MDI is responsible for cleaning the bins on an as needed basis.

The housekeepers have some freedom in adapting certain specifics of the work as they wish. For example, some do not empty the white paper bin every day, but wait until it is full. The housekeepers may empty all the trash bins, then go back and collect the white paper. However, all three housekeepers that were observed as part of this study perform both operations simultaneously. The housekeepers have the option of sorting as they empty trash; that is, they may pick out recyclable white paper if they discover it in the regular trash receptacle or pick out nonwhite paper or contamination from the white paper

receptacle. They were instructed to perform this extra function if time permits. [4] It appears that some housekeepers have taken it upon themselves to do this extra sorting while others elect not to. (It is, however, each office employee's responsibility to place his trash/white paper in the proper receptacle.) Each of the regular trash receptacles are lined with a plastic bag. It was observed that one housekeeper attached a plastic liner to each receptacle with a rubber band. The other two did not. Two housekeepers removed the plastic bag from each receptacle regardless of amount of trash (unless, of course, the container was empty). The other housekeeper was observed to empty the container even if the trash was minimal and the plastic liner clean. It was noted that cross contamination of the white paper bins was minimal (however, refer to Section 3 concerning the visual inspection of the recycle bins), but that potentially recyclable paper was often inadvertently placed in the trash bin. Even though there was an aluminum can recycle bin at the end of the hallway, twice it was observed that recycle receptacles contained soft drink aluminum cans. Where this happened, one of the housekeepers picked the cans out, emptied the contents into the regular trash and collected the cans in a separate bag on his cart, to be dumped into the recycle bin later. The other housekeeper dumped the cans into the regular trash. Only one employee was found not to have a white paper receptacle at his desk. (When employees move from one building to another, some take their recycle bins with them, while others do not.) It was reported that a separate bin was kept on each floor of Building 4201 for departing employees--to receive the paper from cleaning out of desks. It appears that the housekeepers are often familiar with methodology/peculiarities of their coworkers and can adapt any of these methods, if desired. (The only suggestion made when asked by the observer, was a desire to improve the number of recycling participants. One housekeeper estimated that as much as 25 percent of white paper is put into the regular trash.) It was observed that some copy machines did not have recycle bins. A bin was observed at a paper shredder.

If there is a large amount of cardboard collected on a daily round, then that housekeeper is expected to deposit the cardboard into the designated roll-off bin. MSFC has only one 20 yard bin for recycling of cardboard. It is located at Building 4471. The cardboard is collected by BFI on an as needed basis, the company being notified when the bin is full. Service is usually same day.

In addition, there are thirteen 20 yard roll-off bins for large trash items, such as scrapped building materials (partitions, filters, piping), wood (studs, damaged and unusable pallets), foam, construction and decommissioning debris. Corrugated cardboard that is not recycled is also tossed into the roll-offs. The location of these bins is contained on Table 4. Generally, Mr. Hopkins of MDI monitors these bins and empties them on an as needed basis. The 20 yard bins containing the foam and the one used for cut grass and leaves is emptied at the RSA inert landfill located to the east of the East Marshall Test Area. [7, 9] The remaining 20 yard roll-off bins are taken to the Huntsville landfill located at Leeman Ferry and Airport Road. [9] (Mr. Hopkins does limited sorting before loading a bin on the truck; that is, he will take metal inadvertently placed into one of these bins and place it into a metal recycle bin. He will likewise remove wood or other trash from a recycle metal bin

and place it in the proper container. [9])

In addition to the above, laser printer cartridges are recycled. Normally each spent cartridge is deposited in specially marked bins or stacked in copy rooms. When returned, MSFC gets a rebate to offset the cost of purchased "refilled" cartridges. The MSI contractor is responsible for this program. However, it was reported that they must consistently purchase ~30 percent new cartridges due to no returns. [8]

Paper shredding of sensitive documents occurs at various centrally located buildings throughout the MSFC facility. Surrounding buildings will deliver their shredded paper to these designated buildings for pick-up every first and third Wednesdays. A mobile truck collects the shredded paper for delivery to the Huntsville incinerator. [7]

In addition, there is a 2 cubic yard bin located under the sawdust discharge on the south side of Building 4471. The contents of this bin (which frequently contains refuse other than sawdust) is transferred to the MDI front-end loader and hauled to the Huntsville incinerator with the other "bin" trash. [9]

#### Scrap Metal

MSFC presently has a program in place for the recycling of scrap metal. Metals recycled include, mainly, aluminum, Al Li, irony aluminum, light and heavy steel, and mixed. There are nine outside bins used for the recycle of metals. Refer to Table 1 and Table 4 for locations, types and sizes. (Note: There are numerous smaller bins located inside various shop buildings. However, all material collected here is deposited into the larger outside bins. [7])

The scrap metal is transported by the MDI hauler to the Redstone Arsenal DRMO to be sold as scrap. Proceeds from this sale go the U. S. Treasury; they are not returned to MSFC. [15] Quantities of scrap metal are contained in Section 3.

In addition, Building 4728 has a 2 cubic yard bin and Building 4650 a 4 cubic yard bin for used insulated wiring. All such wire is taken by MDI to Building 8025 for processing as surplus. [9]

#### Office and Flight Surplus

Surplus MSFC office equipment, supplies, furniture, and flight hardware are processed through Building 8025 and stored there or in an adjacent fenced area until disposed of. A portion of Building 8025 is also used as a storage area for usable office furniture and incoming supplies. Initially any "non flight" item received is placed on a surplus list for circulation at MSFC. (Flight hardware or artifacts are discussed separately below.) A listing is also kept of surplus items at other centers. The MSFC employees have thirty days to request a surplus item. If the item goes unclaimed, it is placed on a list for circulation

among other federal and state government agencies. If still unclaimed, it is disposed of in a number of ways. Any electronic equipment thought to contain gold, silver or other precious metals is sent directly to the Defense Reutilization and Marketing Office (DRMO) for extraction of the metal. (Whether or not an item contains precious metals is a judgment call.) Of the remaining items, those deemed salable, are tagged for resale and moved to the rear of the building [15].

Resales are conducted by the General Services Administration (GSA). Most items are auctioned off to the general public at Building 8025 in large lots. Some (mostly unique, individual items) are sold by sealed bid. There are three to four such auctions per year.

If the item is deemed not salable, it is sent to DRMO for disposal. (Salability is determined by consulting published stock class listings. The item must also be in relatively good condition.) Also, if no bid is received on an item or lot, it too is sent to DRMO for disposal. However, this is rare. For the last sale, only two of the 216 lots did not receive a bid. [16] (There is no reserve or minimum bid requirement.) Proceeds from GSA sales are returned to MSFC. Any proceeds on items disposed of by DRMO go to the U.S. Treasury. [15]

Excess "flight" hardware has historical significance and is deemed an artifact. The artifacts are processed through Building 8025 as are all excess items. The Smithsonian Institute is given first refusal of all artifacts. For example, all missiles presently on display at RSA actually belong to the Smithsonian and are on loan. Such missiles are demilitarized per stringent EPA regulations. If another facility wishes to have the artifact (such as AMES), these two agencies decide between themselves where the artifact will go. [15]

Spent solid rocket boosters are reused if possible. If damaged, they are usually sent to Hill Air Force Base to use for target practice. If Hill AFB does not want the boosters, they must be cleaned out before being disposed of. Sometimes schools or others request the boosters for special exhibits. If not, the boosters are sold to scrap dealers. Most MSFC missile and space shuttle contractors, such as the Thiokol Corporation and Martin Marietta, have contracts with local scrap dealers to dispose of unusable metal missile components. The proceeds from contractor sales to scrap dealers is credited to their MSFC contracts. [15]

No accounting is kept of the amount or type of items processed through Building 8025. The only information that is available are GSA sale proceeds. An estimate of proceeds is in Section 3 of the report. However, a tour by project participants revealed a large number, ~75 percent, of the items in Building 8025 to be surplus (dumb) computers and computer peripherals. The outside fenced area contained such items as metal gratings, trunks, cabinets, computer cases, satellite disks, an ice machine and refrigeration compression system. The type of items are often received in stages; i.e., if the center is upgrading their Cray computers, Building 8025 will receive a large number of excess Crays around the same time frame.



## Other

The following items are handled by separate contracts and were not considered part of this study. The items are listed to provide as complete a picture as possible of MSFC waste and current recycling practices for the reader.

**Hazardous Waste.** The hazardous waste is under the NASA Environmental Management Office. It is collected, segregated and shipped by the MSI Contractor. A study has already been completed by CH2M Hill analyzing the various hazardous wastes at MSFC. [7]

**Motor Oil.** Used motor oil from the motor pool, Building 4483, is collected and transported to Auburn University where it is burned as fuel for building heat. [1]

**Tires and batteries.** If possible, tires are recapped and reused. Unusable tires and batteries are disposed of by the DRMO. [1]

In September 1993, The University of Alabama, Huntsville undertook a study [17] for the United States Army Missile Command to analyze the RSA waste stream involving all buildings with the exception of those designated MSFC and restricted areas. This consisted of 376 buildings with 431 adjacent dumpsters plus single family housing units. About 7244 tons per year of solid waste is collected from these facilities and transported to the Huntsville incinerator and Huntsville landfill for disposal. The study indicated that about 3360 tons per year of this amount would be office waste. At the time of the study, there were four recycling programs being operated by the Department of Army at the RSA:

1. Office paper; ~ 250 tons of white/computer paper recycled in 1993.
2. Aluminum cans (office); ~10.8 tons recycled in 1993.
3. Corrugated Cardboard (commissary); ~120 tons recycled in 1993.
4. Curbside Materials (for Residential area); ~73.5 tons (newspapers, glass, plastics, steel and aluminum cans, #1 and #2 plastic) recycled in 1993.

This is in addition to the material and items sent to DRMO and subsequently recycled (used oil, lead acid batteries, meat, fat and bones from the Commissary, and scrap metals.) (Note: Per the DRMO, ~ 1500 tons of various scrap metal were processed by them for recycling in 1993. The DRMO collects materials from not only the RSA, but also from MSFC, Arnold Air Force Base in Tullahoma, TN, and the Ammunition Plant in Chattanooga, TN. [17])

A listing of bins by pick-up schedule was provided by MSFC. It was resorted by building number to facilitate the visual inspection portion of the study. Table 2.1, indicates discrepancies found in the original list. "List" data found to be different during the visual inspection has been crossed out with "visual" information indicated in bold italics. Also, information that had been missing from the MSFC list was added and is so indicated in bold italics. Per the listing, 95 MSFC buildings have a total of 172 bins. The visual inspection indicated 112 bins with different or incomplete data from that supplied. These

differences included location or bin size, bins not found at the buildings indicated (13 bins), and bins found at buildings not listed (seven bins). It should be noted that this inspection was carried concurrently with the visual sort. An attempt was made to inspect the bins prior to their scheduled pick-up. Therefore the inspection was done bin-by-bin and not building-by building. Because of this, there could exist buildings with bins that were not on the MSFC-supplied bin list, and therefore, were never inspected. However, the likelihood of this is considered small. Also the pick-up schedule (days on which the bins are emptied) supplied by MSFC was not verified.

It is especially important to note that refuse collection is a dynamic situation; that is, bins are frequently moved based on current need. [4] This is especially true of roll-off bins, which are often relocated to current construction or decommissioning sites as the need arises then returned to their assigned buildings. The visual inspection portion of the study took place over a three month period. Every effort was made to provide an accurate list and to account for every bin, even to the point of inspecting select bins/buildings a second and third time. Even so, this list may not reflect the current situation.

Table 1. MSFC Corrected Listing of Solid Waste Refuse and Recyclables (1)

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4189	North	Refuse	4 2
4194	West	Refuse	6 8
4200	North	Refuse	8 2
	South (Dock)	Refuse	8
	Dock-SW Corner	Recyclables-white paper	6
4201	East	Refuse	8
4202	East	Refuse	8
4203	East Southeast	Refuse	6
	North Southeast	Refuse	8
	Northeast	Refuse	8
	North	Recyclables-white paper	8
	North	Recyclables-white paper	6
	South Parking Lot	Roll-off-grass and leaves	20
4207	East North	Refuse	2 6
	Northeast North	Refuse	2 6
	Southeast (3)	Refuse	8
4241	South	Refuse	2 6
4244	West	Recyclables-white paper	6
	West (13)	Recyclables-aluminum cans	8
	West	white paper	8
	West	Recyclables-aluminum cans	8
4249	East	Refuse	6
4250	West	Refuse	8
	West (3)	Refuse	8
4251	West	Refuse	6 4
4306 (2)	East	Refuse	2
4312	East West	Refuse	6 4
4313	East	Refuse	6
4347	North	Refuse	2

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4348	North	Refuse	6
	North	Refuse	6
	North	Roll-off-metal	20
4353	Northeast	Refuse	6
	North	Refuse	6
4436	West	Refuse	2
4466	North East	Refuse	2
	South	Refuse	2
4471	South North	Refuse	8
	South	Refuse	6
	South North	Refuse	6
	South North	Refuse	6
	South	Refuse	6
	South (4)	Refuse	2
	South	Roll-off-cardboard & wood	20
	South	Recyclables - cardboard Roll-off	20
	Northeast	Recyclables-white paper	6
4475	South East	Refuse	2
4476	South	Refuse	4
4481	West (3)	Refuse	8
	North	Refuse	8
	Northeast	Recyclables-white paper	6
4482	South	Refuse	8
4483	South	Refuse	4 8
	Southwest (5)	Refuse	4
4485	Northeast	Refuse	6
	Southeast	Refuse	4
4487	(8) <del>A Wing East West</del>	Refuse	8 6
	<del>A Wing West Southeast</del>	Refuse	4 6
	<del>A&amp;B Wings West Northeast</del>	Refuse	2 4
	<del>C Wing West East</del>	Refuse	2 6
	Northwest	Refuse	2
4491	Southwest (3)	Refuse	4
	East Northwest	Refuse	4
	Southwest Northwest	Recyclables-white paper	6

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4492	Northwest East	Refuse	6
4494	North (3)	Refuse	3
	North Northeast	Refuse	2
4495	North	Refuse	2
4498	East West	Refuse (6)	8
		Roll-off cardboard & wood (3)	20
4524	East	Refuse	3
4531	Northwest	Refuse	6 2
4539	Northwest	Refuse	3 2
4549	West	Refuse	6 4
4551	South	Refuse	6 2
4553	East Northeast	Refuse	8
4561	TRL 244 TRL 4561A (3)	Refuse	2
	South	Refuse	6 4
4570	East	Refuse	6
	North Test Area (14)	Recyclables white paper	
4572	South	Refuse	6 4
4582	East	Refuse	8
4583	South	Refuse	8 6
4588	North	Refuse	6 4
	(10)	Roll-off-cardboard & wood	20
		Roll-off-metal	20
4596	Northeast	Refuse	3 2
4605	North	Refuse	4
4610	South	Refuse	8
	Southeast	Refuse	6
	Trailers	Refuse	6
	South	Recyclables-white paper	6

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4612	East	Refuse	3 8
	East	Refuse	4
	East	Roll-off-metal	4 2
4614	West	Refuse	8 4
4619	South	Refuse	6
	South	Refuse	4
	South	Roll-off-cardboard & wood	20
4623	East	Refuse	3 6
4626	South	Refuse	6
4628	East	Refuse	2
4629	South	Refuse	2
	Southeast (3)	Refuse	2
4640	North	Refuse	4
		Roll-off-metal (9)	8 20
4646	Northeast	Refuse	4
4647	Northwest Southwest	Refuse	2
4648	North	Refuse	2
4649	Southwest	Refuse	4
4650	West South	Refuse	6
	West North	Refuse	4
	West (7)	Refuse	6
	West	Roll-off-cardboard & wood	20
	West	Roll-off-metal	20
	West	Recyclables Roll-off-wire	8 4
4653	Southwest	Refuse	6
4654	West	Refuse	2
4655	North	Refuse	3 4
	South	Refuse	4 2
4656	East	Refuse	2

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4659	North	Refuse	2
	South (3)	Refuse	4
4663	South West	Refuse	8
	West South	Refuse	6
	Southwest	Recyclables-white paper	6
4666	Southwest	Refuse	8 4
	Southwest West	Refuse	8 6
	West	Recyclables-white paper	6
4667	South	Refuse	2
4671	South	Refuse	8
	East	Refuse	2
4674	South	Refuse	8 6
4678	North South	Refuse	2
4702	Southeast	Refuse	4
4705	West	Refuse	8
	West	Roll-off-metal shavings	20
	West	Roll-off-metal	20
	West	Recyclables-aluminum 2	
	West	Roll-off-metal shavings	20
4707	East	Refuse	4
	East	Refuse	6
	East	Refuse	8
	East	Roll-off-wood & cardboard	20
	East	Roll-off-foam	20
	East	Roll-off-foam	20
	East (12)	Roll-off-foam cardbrd/box brd	20
	East	Recyclables-white paper	6
4708	Northwest East	Refuse	2 8
	Southwest	Refuse	6
	Southwest West	Refuse	6
	Northwest	Refuse	6
	West (15)	Roll-off-cardboard & wood	20
	Northeast	Recyclables-white paper	6

<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
4711	North	Refuse	8 6
	North (3)	Refuse	8
	North	<i>Recyclables Roll-off-metal scrap</i>	2
	North	<i>Recyclables Roll-off-aluminum plate</i>	2
	North	<i>Recyclables Roll-off-aluminum shavings</i>	2
	North	<i>Recyclables-aluminum shavings</i>	4
4712	North	Refuse	8
4718 (3)	Southeast	Refuse	8
4723	North	Refuse	2 4
4727	North	Refuse	4
4728	South	Refuse	8
	South	<i>Recyclables-electric wire</i>	2
4732	West	Refuse	4
4746	<del>Southwest</del> West	Refuse	2
4747	West	Refuse	2
4750	<del>Sand-Blast</del> Picnic Area	Refuse	2
4752	South	Refuse	2 4
4755	West	Refuse	8
	West	Refuse	8
		<del>Roll-off-cardboard &amp; wood</del> (3)	20
		<del>Roll-off-metal</del> (3)	20
	West	Recyclables-white paper	6
4774	West	Refuse	2
4775	<del>West</del> (3)	Refuse	6
	South (3)	Refuse	6
4777	West	Refuse	4
	North (11)	Roll-off-cardboard & wood	20
4817	<del>West</del> South	Refuse	6
8023	North	Refuse	8
	North	Roll-off-cardboard & wood	20



<u>Building Number</u>	<u>Location of Bin</u>	<u>Bin Type</u>	<u>Size</u>
8025	<i>Southeast</i>	Roll-off-cardboard & wood <del>Roll-off-cardboard &amp; wood (3)</del>	20 20
Archery Club	<i>South</i>	Refuse	2
Huntsville Police Department	<i>East</i>	Refuse	4 6

1. Data found during the visual inspection to be at odds with the MSFC supplied listing have been crossed out with "visual" information supplied in bold. Missing information is also shown in bold. It was assumed that the MSFC listing showing multiple bins of the same size, type and location were assumed to be the same bin with different pick-up dates. Listings showing more than one pick-up on the same day (i.e., bins listed as Friday pick-up and every day pick-up) were assumed to consist of two bins although this may have been a misprint.
2. No refuse or recycle bin found. This building is under construction.
3. Bin is missing and presumed removed or relocated.
4. Located beneath sawdust discharge. Contained general refuse.
5. Non-standard open bin located behind MDI refuse bin.
6. Bin not being used by building.
7. This bin could be assigned to Building 4663.
8. As it was not possible to discern building wings, locations where bins were located have been added.
9. This recycle bin was not found. Per Mr. Hopkins of MDI [9], this building no longer has a metal container.
10. These two roll-off bins were located south of 4557/4558.
11. This bin is attached to a large tank and is covered.
12. An initial inspection revealed three foam roll-offs. A recent inspection indicated one of the foam roll-offs was being used for cardboard/box board recyclables.
13. When these bins were inspected initially, there were two aluminum can and one white paper recyclable bins. When checked recently, there were one aluminum can and two white paper bins.

14. When this building's bins were initially inspected, it included one white paper recycle bin. When rechecked recently, the recycle bin was missing.
15. When this building was initially inspected, it had tow 20 yard roll-off bins. However, a recent inspection indicated only one roll-off.

### **Section 3**

#### **Data Collection and Analysis**

##### **Options Considered and Methods Selected**

There are two primary methods for conducting a waste characterization study. [14] First is a source-specific method in which the individual components of the waste stream are sampled, sorted, and weighed. This is the method usually used in analyzing local waste streams. The second is a material flows method which is based on production data, product lifetimes and other information (much like a mass balance in which raw material minus product equals waste). This study used the first method to arrive at an estimate of waste stream composition.

In addition, there are numerous options that could be employed in the source-specific method of analysis. The options selected were based on maximizing the probability for an accurate composition, while keeping within the time frame required for completion of the report and manpower available to help in the visual and manual sorts. These options included: visual inspection of each bin or of preselected or random bins or of preselected or random trucks; manual sorting of a limited number of preselected bins; or of random bins; or manual sorting of a grab bag taken from a random sampling of bins.

It was determined that time and manpower permitted a visual inspection of each bin at least one time. This was done as opposed to visually inspecting preselected bins or random bins as this would allow project participants to verify the bin and container listing supplied by MSFC concurrently with the visual inspection. The visual inspection, although providing only gross estimates of garbage composition, would indicate the major contributors to the waste stream, and it would flag those unique bins and containers that had abnormally high components of one or two potentially recyclable materials. A random sorting may have missed these. Also, the visual inspection would provide information to be used in preselecting the bins for manual sorting. The visual inspection indicated that a grab bag sampling would not have been too effective as the bins often contained large bags or stacks of the same type of refuse. (Note: Most residential trash contains smaller, more mixed waste, resulting in good results obtained from sorting a random number of grab bags.)

The bins for manual sorting were preselected to ensure selection of what was considered a typical or "normal" waste stream. It was also felt that this would concurrently identify those components that had the maximum recycling potential in terms of quantity and price. For example, office waste was predominantly selected for sorting; it typifies MSFC buildings and also produces commodities for which there are known markets. The number of bins sorted was impacted by the personnel available to perform this task. Even so, it was thought that seasonal, weekly, or monthly fluctuations would be minimal, and that any such changes would not significantly affect the composition of the waste stream. (Note: 1994

tare receipts for solid waste refuse were obtained. The monthly totals were computed as follows: Feb: 91.8 tons, Mar: 111.3 tons, Apr: 94.8 tons, May: 116.9 tons, Jun: 121.4 tons, Jul: 85.2 tons, Aug: 118.8 tons, Sep: 116 tons, Oct: 105.6 tons, Nov: 101.7 tons, Dec: 92.9 tons for a monthly average of about 105.13 tons or about 1261.5 tons per year.)

In addition, information was available from "truck" receipts and a log concerning content, weight, and number of trips over a specified time span. There was also available published information [12] on number of personnel per building, along with usable floor space (which is broken down into office, laboratory, technical facilities, conference room, shop, storage, and miscellaneous). This information was also used in analyzing the waste stream and in evaluating the accuracy of the visual and manual sorts.

### Visual Sort

Each of the 172 MSFC building bins were visually inspected for content. Table 2 gives a breakdown of garbage components by volume percentages. (For example, the bin for Building XXXX contained 35 percent office paper when visually inspected.) By the nature of this inspection, these volume percentages are gross values. Also, items such as magazines and aluminum cans could very well have been hidden from view, and, therefore, would have gone unreported. This is substantiated by the manual sort which indicated a significant amount of aluminum cans are ending up in the general refuse. The visual inspection revealed a relatively homogenous mix (as compared to residential trash). In addition, the garbage was often segregated into plastic bags; that is, one or two bags would contain almost all restroom paper towels, almost all paper plates and cups, or large quantities of office waste. Although one inspection is inadequate to make conclusions, it is suspected that certain buildings would consistently have higher volume percentages of certain types of trash. In general the bins were highest in food and drink waste (mainly containers and wrappers), corrugated cardboard, and restroom paper towels. In fact, paper towels were added as a separate item when initial inspections revealed how abundant they are. Noticeably absent was computer paper, due, no doubt, to the increasing popularity of PC's and laser jet printers.

The "% Full" column of Table 2 sometimes contains two numbers. The first number gives the percentage full when visually inspected. The second number is the normal volume of the bin when emptied. These latter numbers were supplied by the MDI contractor. [9] If in agreement, only one number is given.

In only one of the refuse bins inspected were the cardboard boxes broken down or flattened. Therefore, although this constituent appeared extremely high in some cases, it would have a high volume to weight to ratio. It was found that the density for the boxes as they were found in the bins would be about eight pounds per cubic yards, compared to a density of about 150 pounds per cubic yard for flattened and stacked boxes.

Table 2. Visual Sort of MSFC Solid Waste Refuse Bins (1)

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (S)	Newspapers	RR Towels	Mags.	Other	% Full (1)
4189	North	2		35	25	10		30					5
4194	West	8			15	10		15	20	15		paper uniforms - 25	40(80)
4200	North S Dock	2 8		10 20	60 20	5 20		25 10					35(100) 85(100)
4201	East	8		20	20	15		45	10				40(75)
4202	East	8		15	10	5		25		45		aluminum cans	45(75)
4203	SE	6			15	10		45	10				5(20)
	SE	8			15	10		45	10				40(70)
	NE	8		15	10	20		45	10			aluminum cans	60(90)
4207	North	6	10	20	15	20		25	7			wire - 3	40
4241	North South	6(2) 6		40	10	10		15		15		hose - 10	0(5) 50
4249	East	6		30	15	20		35					50
4250	West	8		40	5	28	2	10			5	blue line - 10	75
4251	West	4			50	20		10		20			100(80)
4312	West	4	20	30	20	10		10	2	8			90

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (S)	Newspapers	RR Towels	Mags.	Other	% Full
4313	East	6		30								computer cards - 40 desk, chair - 20 manila folders - 10	40(20)
4347	North	2		40	10	20 (6)		10	5	15			30(10)
4348	North	6			15	15		20				leaves - 40 grass - 10	30
4353	NE	6		10	20	10		50		10			20(50)
4436	West	2			3	15		50	12	20			100
4466	East	2		15	5	22		40	3	15		aluminum cans	25
4471	North	8			30	10		30	5	25			45
	South	6				100							10
	North	6											0
	North	6	5		15	5		70	5				50
	South	6			100								2
	South	2 (7)						50	25			wood - 25	5
4475	East	2		15		5		20	10	50			15
4476	South	4			60	20		10	5	5			30(40)
4481	North	8		15	10	20		35		20			40(70)
4482	South	8			30	20 (6)		15		10		metal trash can - 15 hose - 10 Styrofoam - 10 wood - 60 scrap metal - 40	40(50)
4483	South S (12)	8 4			75	15							95
													120

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (#)	Plastic	Glass	Food/Drink Waste (\$)	Newspapers	RR Towels	Mags.	Other	% Full
4485	NE	6	30	15	15			28		10		light bulbs - 2	30(50)
	SE	4		35		10		25		20		foam - 10 aluminum cans	45(50)
4487	West	6		10	50	5		20		15			100
	SE	6		40	15	5		20		15			80
	NE	4		18	65	5			5	5	2	carpet - 5	50(70)
	East	6		8	10	10		20		20	2	velum - 30	40
	NW	2			100								2(10)
4491	NW	4		40	10	10		20		15		rags - 5	30(95)
4492	East	6		5	50	15		15		15			40(60)
4494	NE	2		10	20	20		40			10	(14)	15
4495	North	2				30		15		55		rags - 10	10(80)
4498	West	8 (13)				50			40		10		2(15)
4524	East	2			20	20 (6)	2	18	20	20			30(20)
4531	NW	2			30			30	5	30		metal shavings - 5	50
4539	NW	2			30	10		30	5	20		wire - 5	90
4549	West	4				20		40	20	20			20(40)
4551	South	2 (3)											0 (10)
4553	NE	8			10	20 (6)		35	5	30		aluminum cans	30
4561	South	4		5	15	20		40		20		aluminum cans	120

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (S)	Newspapers	RR Towels	Mag.	Other	% Full
4570	East	6		10	20	15		25		30		aluminum cans	30(50)
4572	South	4		15	5	15		40	5	20			30
4582	East	8 (3)										~ 8 inches of water	~0
4583	South	6			30	5		30	20	5		white bond paper - 10 aluminum cans	60
4588	North	4		5	15	20		35	5	20		aluminum cans	80
4596	NE	2			30	10		50	5			rag - 5	60
4605	North	4		5	20	30		10	5	30		aluminum cans	25
4610	South SE Trailers	8 6 6			10 95	10 5 20		40 40		40			15 20 50
4612	East East	8 4			20	15 20		40 50	10	15 20		foam - 5 aluminum cans wood - 5 grass - 5	30(80) 15
4614	West	4		15		25		15	5	40			35
4619	South South	4 6 (15)		15	5	10		40		10		gift wrap - 20	60 0 (60)
4623	East	6			50	20		20				rag - 10	10(95)
4626	South	6			30	10		35	20			aluminum cans electric wire - 5	10



Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (5)	Newspapers	RR Towels	Mags.	Other	% Full
4628	East	2		10	20	30		20	20				5(55)
4629	South	2				40		30	5	20		wood - 5	40
4640	North	4			40	60 (6)							20
4646	NE	4			20	30		30	10	10		aluminum cans	40(60)
4647	NW	2 (10)		5		5		80		10		aluminum cans	40
4648	North	2			25	20		35		10		metal cans - 10	55
4649	SW	4		5		10		25	5	15		wood - 40	20
4650	South North West (16)	6 4 6			90 40 30	5 20 40		30 15	5 5 5			aluminum cans	3(80) 40 50
4653	SW	6		5	50	10		20		15			50(90)
4654	West	2		5	5	50		20		20			30
4655	South North	2 4				40 10		20	20	20		wood - 10	50 90
4656	East	2					10	10				brown wrap paper - 80	25
4659	North	4		20	20			35	5	20		aluminum cans	20(50)
4663	West South	8 (10) 6		10		30 30		55 40		5 30		aluminum cans	15(90) 15(80)
4666	SW West	4 6		5 30	20 10	20 25		15 10		40 20		blue line - 5	25 25(50)

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (5)	Newspapers	RR Towels	Maga.	Other	% Full
4667	South	2			35	15 (6)		20	10			ceiling tiles - 10 pipe insulation - 10 aluminum cans (9)	30
4671	South	4		10	35			10	10	15		windows (wood and glass) - 10 aluminum reel holders - 10 scrap metal - 100	95
4674	East	2											10
4678	South	6		30	20	20		10		10			60
4702	South	2			35	15 (6)		5		40		scrap metal - 5 aluminum cans	40(70)
4705	SE	4			20	10		50		15		paper uniforms - 5	30
4707	West	8		5	20	15		40		20			60(90)
4708	East	4		10	30	30		20				wire - 10	80
	East	6		5	25	60		10					40
	East	8		5	15	10		45				vellum - 5 aluminum cans electric cord - 5 white bond paper - 25 aluminum cans foam - 5	60(100)
	SW	6				40		30	5	15			30(80)
	W	6			30	10		60 (11)					25(90)
	NW	2				5		90					60(100)
4711	North	6		30	20	15		30	3		2		15(90)
4712	North	8		15	40	20 (6)		15		10			90

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (5)	Newspapers	RR Towels	Mags.	Other	% Full
4723	North	4		25	4	4	2	30		35			20(80)
4727	North	4		15	30	15 (6)		30	5			aluminum cans light bulbs - 5	40(90)
4728	South	8		10	50	5		32	3			aluminum cans	80
4732	West	4		10	5	20		15	10	30		sheet metal - 10 aluminum cans	30(50)
4746	West	2		10	10	10		40	5	25			100
4747	West	2			5	10 (6)		25	10	20		foam - 5 rags - 25 aluminum cans	30
4750	Picnic Area	2			20	30 (6)		30	10			aluminum cans - 10	30(50)
4752	South	4			40	10		25		20		light bulbs - 5	30(50)
4755	West West	8 8			30 20	20 10		30 10	5 10			light bulbs - 15 metal shavings - 20 plastic shavings - 30	50 35
4774	West	2				30		65				wood - 5	25(40)
4777	West	4			10	20		30	10	15		light bulbs - 5 metal pipe - 5 carpet - 5	35(50)
4817	South	6	5	30	15	15		30	5				30(70)

Bldg.	Location of Bin	Bin Size	Computer Paper	Office Paper	Cardboard (4)	Plastic	Glass	Food/Drink Waste (5)	Newspapers	RR Towels	Mags.	Other	% Full
8023	North	8			30	10		10	5			packaging paper - 15 Styrofoam - 5 paint cans - 15 rags - 10	80
Arch-ery Club	South	2			50				30		10	rifle case - 5 miscellaneous cans - 5	10
HPD	East	6			80	3		17				aluminum cans	35(40)

1. Number in parenthesis is MDI estimate of average percent full when bin is emptied. Where the visual inspection is in agreement with MDI, only one number is shown.
2. Although this bin was empty, because it is located alongside the other bin for this building, it is anticipated that the refuse composition would be the same.
3. These bins were checked on two dates for contents and found empty or nearly so both times.
4. Cardboard boxes were not broken down, and, therefore, this constituent would have a high volume-to-weight ratio.
5. Food and drink waste includes lunch bags, wrappers, paper and Styrofoam plates, cups and containers and food stuff. Packing Styrofoam was usually included in this number, if not a significant constituent.
6. Almost all plastic reported was film (largely bags). These bins also contained visible rigid plastic.
7. Located under sawdust discharge. Bin was labeled "SAW DUST ONLY."
8. Packing Styrofoam.
9. Also a discarded refuse bin and wooden spool were beside the regular refuse bin.
10. Strong odor.
11. One inspection on a group of bins was performed on 12/20. Some of these bins (so indicated) appeared to contain a high amount of paper plates and cups.
12. Open nonstandard container located behind the MDI refuse bin.
13. This building is no longer in use and (per manager), the bin can be removed. The reported contents were the result of drive-by drop-offs.
14. Also one wooden pallet and one office partition beside bin.
15. The second time this location was visited, the 6 cubic yard bin was missing.
16. This bin may be assigned to Building 4663.

Food and drink waste, by and large, consisted of Styrofoam and paper containers and cups, plastic cups and utensils, fast food wrappers, and lunch bags. Very little actual food or organic matter were noticed, although in some cases the food stuffs would have been wrapped. If packing Styrofoam was present in the bin, but not in significant amount, it was included with this number. Approximately fifteen bins were empty or nearly so during the initial inspection. Those bins were inspected a second time. If found empty on the second inspection, this was so indicated on the table.

### Manual Sort

During the week of December 12, 1994, six bins were delivered to a tractor barn located north of Building 4348 for manually sorting by four project participants. Large bins with frequent pick-ups were selected from buildings thought to provide a representative sample of the waste. The buildings and bins are described below. Fifteen waste components, as given in Table 3, were sorted by placing each piece of trash in separate 22 gallon trash containers. The containers were then weighed, and subtracting the weight of the container itself, the weights of each component per bin were recorded. The weights are given in Table 3 along with the percentage by weight that each component constituted.

<u>Building</u>	<u>Scheduled Pick-Up</u>	<u>Description of Building</u>
4203	Every Day	Six story office building plus a basement with 131,651 square feet of usable floor space, of which 80,250 square feet is office space. [12] This building houses 705 personnel [12] and contains a travel office, cafeteria, heritage gallery, gift shop, and barber shop.
4250	MTWF	A one story building with 23,929 square feet of usable floor space, of which 19,158 square feet is for offices. It houses 147 personnel. [12]
4471	Every Day	A one story building with 82,122 square feet of usable office space, of which 23,048 square feet are offices and 34,598 square feet is for storage. It houses a cafeteria and 193 personnel. [12]
4666	Every Day	A three story building with basement. It contains 43,943 square feet of usable floor space, of which 35,705 square feet are offices. It houses 236 personnel. [12]
4705	Every Day	A four story building with 175,378 usable square feet of floor space, of which 111,788 square feet contains a metal fabrication shop. It houses 173 personnel. [12]

4708	Every Day	A two story building with basement, with 178,211 square feet of usable floor space, of which 66,444 square feet are offices, 56,522 square feet contains a shop, and 21,722 square feet is laboratory space. It houses 520 personnel. [12]
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Buildings 4203 and 4250, which are mainly offices, had large percentages of white paper (37.4 and 17 percent respectively). It should be noted, however, 50 percent of the white paper reported for Building 4250 was blue-line drafting sheets, which cannot be recycled as white paper. Buildings 4471 and 4708 had large quantities of cardboard (31 and 24.9 percent respectively). These two buildings house a receiving area (4471) and a fabrication shop (4708). In fact, cardboard boxes constituted a large percentage of the bin volume as they are discarded whole (unflattened). (It is interesting to note that the only designated recycle corrugated cardboard container for MSFC is stationed at Building 4471.) Overall, colored paper turned out to be only a fraction of that for white paper (15.6 to 2.5 percent). Computer paper, although a premium commodity, was so scarce as not to warrant a separate column. Much of the plastic film reported was from the bags used in the employee trash bins and in the larger housekeeping containers. Restroom towels, although not a significant percentage of the overall weight, constituted a fairly large amount of the volume of the trash and was usually found in segregated bags. The opposite could be said of the magazines; i.e. high weight-to-volume ratio. There was a surprisingly low volume of food stuffs found. The column titled "Other" contained unique, one of a kind items, or items so commingled with other trash as to not make separation feasible. Refer to the table footnotes for a more complete description of the "Other " category.

The weight of the bins sorted was computed to be 1577 pounds. As the bin trash collected for the Huntsville incinerator was computed at approximately 4.7 tons per day, this represents about 17 percent of the trash collected for any one day.

#### Additional Bins

MSFC already recycles a number of commodities. These "recyclable" bins are shown on Table 4 in bold type. Twelve 6 cubic yard and two 8 cubic yard white paper bins were accounted for during the visual inspection, as well as one 20 yard corrugated cardboard bin and fourteen various metal and insulated wiring bins, including one specifically for aluminum cans. (Note: In addition to these items, MSFC also recycles waste oil, used tires, lead batteries, and motor oil, surplus office equipment and supplies as well as flight artifacts [see Section 2], plus the facility composts grass and leaves and chips of small tree limbs for mulch.) This table also lists the 20 yard "foam" roll-off bins and the one "grass and leaf" roll-off which are hauled to the RSA inert landfill. [7, 9] (It is interesting to note that many of these container contents are landfilled even though the containers are designated for specific types of trash only.)

Table 3. Manual Sort of Six MSFC Refuse Bins

SOLID WASTE WEIGHTS (POUNDS) AND WEIGHT PERCENTAGES

Bldg	White Paper	Colored Paper	Box Board	Corrugated Cardboard	Plastic Film	Rigid Plastic	RR Towels	Newspaper	Magazines	Food Stuffs	Aluminum	Glass	Steel Cans	Cloth	Other	Total Weight
4203 (1)	147	11	23.5	5	8	8	27.5	39	26.25	4.5	5.25	7.5	2	>0.5	79 (2)	393.5
percents:	37.4	2.8	6	1.3	2	2	7	10	6.7	1.1	1.3	1.9	0.5	-0	20	
4250 (3)	61 (14)	2.5	19	24	9.5	10	20	27.5	34.5	20	4.5	7	5.5	>0.5	114.5 (4)	359.5
percents:	17	0.7	5.3	6.7	2.6	2.8	5.6	7.6	9.6	5.6	1.3	1.9	1.5	-0	31.8	
4471 (5)	5	5	30	68.5	12.75	5.25	2.5	3	1.5	30	2.5	1	1.5	2	51.5 (6)	222
percents:	2.3	2.3	13.5	31	5.7	2.4	1.1	1.4	0.7	13.5	1.1	0.5	0.7	0.9	23.2	
4666 (7)	11.25	2	4.25	>0.5	5.75	1.5	12.25	4.25	13.5	2	3.75	>0.5	0.75	>0.5	35.75 (8)	97
percents:	11.6	2.1	4.4	-0	5.9	1.5	12.6	4.4	13.9	2.1	3.9	-0	0.8	-0	36.9	
4705 (9)	19	18	30	56	12	12	9	18.5	27	11	7	8.5	6.5	6	205.25 (10)	444.75
percents:	4.3	4	6.7	12.6	2.7	2.7	2	4.2	6.1	2.5	1.6	1.9	1.5	1.1	46.1	
4708 (11)	3	1	1.5	15	1.5	0.75	1.5	2.5	>0.5	1	1.5	1.5	0	1	28.5 (12)	60.25
percents:	5	1.7	2.5	24.9	2.5	1.2	2.5	4.1	-0	1.7	2.5	2.5	0	1.7	47.3	
TOTALS:	246.25	39.5	108.25	168.5	49.5	37.5	72.75	94.75	102.75	68.5	24.5	25.5	16.25	8	514.5	= 1577
	15.6	2.5	6.9	10.7	3.1	2.4	4.6	6	6.5	4.3	1.6	1.6	1	0.5	32.6	

1. Building 4203 bin size 8 cubic yards, approximately 50% full.

2. Other includes: Food and drink waste, coffee grounds mixed with paper towels, cellophane, Styrofoam - 79 pounds, Five sheets of computer paper.

3. Building 4250 bin size 8 cubic yards, approximately 50% full.

4. Other includes:  
vellum - 24.5 pounds,  
food and drink waste, plastic wrap/bags, Styrofoam, and carbon paper - 108 pounds,  
general shop waste (sandpaper, gloves, tape, paint brushes) - 5 pounds,  
photos - 1.5 pounds,  
batteries (2-C's and 1-AA).
- 5.. Building 4471 in size 6 cubic yards, approximately 85% full.
6. Other includes:  
food and drink waste (large percentage of Styrofoam containers), plastic bags - 47.5 pounds,  
one 8 foot fluorescent shop light, possibly mercury vapor,  
one small strip of wood,  
burlap and rope, foam roll, grass mat, round filter - 4 pounds,  
8-AA batteries.
7. Building 4666 bin size 6 cubic yards, approximately 35% full.
8. Other includes:  
cellulose pipe insulation - 18 pounds,  
food and drink waste, cellophane, coffee grounds - 12.5 pounds,  
rubber - 1.25 pounds,  
2-25 watt fluorescent bulbs,  
2 notebooks, one piece of wood ~ 18" x 1" x 1", one Ajax can - 4 pounds,  
2-AA batteries.
9. Building 4705 bin size 8 cubic yards, approximately 90% full.
10. Other includes:  
food and drink waste, plastic - 165.75 pounds,  
cloth rags - 2.5 pounds,  
overalls - 2.5 pounds,  
2 batteries,  
two pieces of wood - 5 pounds,  
shop waste (electric wire, cords, etc.) - 14 pounds,  
packaging Styrofoam - 0.5 pounds,  
computer disks, flash lights, work gloves, electric cord, face shield, receptacle, nuts and bolts - 15 pounds.



11 Building 4708 bin size 6 cubic yards, approximately 25% full.

12. Other includes:

waxed paper filters - 13.5 pounds,  
wood - 1.5 pounds,  
fiberglass insulation - 2 pounds,  
1 AAA battery,  
rubber and leather gloves - 1 pounds,  
block Styrofoam - 6 pounds  
food and drink waste, film plastic, 2 small pieces of metal - 4.5 pounds.

13. Weights less than 0.5 pounds were not included in totals, but they were noted to signify their presence in waste.

14. Approximately 50% of this total was blue-line drafting sheets which cannot be recycled as white paper. It can, however, be recycled as mixed paper. [20]

The table lists the destination of the recyclable, roll-off contents in the footnotes. However, it is unclear what happens to the product that is piped to the bin for Building 4777. This roll-off appears to be permanently in place. It was empty when visually inspected. It is not handled by MDI. [9]

An additional comment is warranted concerning the foam bin for building 4707. The footnote refers to a type of foam designated MSA-3. This information was supplied by the waste hauler. Further discussions, however, revealed that MSFC has switched to a different type of foam, designated MCC-1, which is manufactured on-site [141] It was reported that other types of foam may be used, but in very small quantities.

Under the "Comments" column is an indication if nonspecified items or contamination of other waste found in the bins. The visual inspection revealed that often this was the case, although most contamination found was minimal and should not pose a problem with acceptance of material by the buyers (either BFI or DRMO). However, this was not the case with Building 4708, in which a large amount of vellum was spotted in the white paper bin.

Overall quantities of roll-off waste and recyclables are contained in a following section of the report.

**Table 4. Visual Inspection of MSFC Recyclables and Roll-Offs (1)**

<b>Bldg</b>	<b>Bin Size</b>	<b>Bin Location</b>	<b>Bin Type</b>	<b>% Full</b>	<b>Comments</b>
4200	6	Dock	white paper (1)	50	Approximately 15% shredded paper. One bond notebook with plastic binder.
4203	20	S Parking Lot	grass/leaves (8)	50	A few scraps from Styrofoam cups and tissues.
	6	Northeast	white paper (1)	60	Approximately 10 colored notebook cover sheets. (Plastic binders had been removed.)
	8	Northeast	white paper (1)	25	
4244	6	West	white paper (1)	25	Approximately 1% colored paper.
	8	West	white paper (1)	35	Approximately 0.5% non-white paper.
	8	West	aluminum cans (1)	50	
4348	20	North	scrap metal (9)	20	Did not inspect--in fenced and padlocked disposal yard.
4471	20	South	cardboard/wood (2)	20	Also contained newspaper, metal and plastic.
	20	South	cardboard (1)		
	6	Northeast	white paper (1)	50	Approximately 2% computer paper.
4481	6	Northeast	white paper (1)	30	Also contained one phone book and one piece yellow paper. Approximately 10% computer paper. (Note: The door to this bin could not be opened very far--too close to dock.)
4491	6	Northwest	white paper (1)	10	Also contained one Styrofoam cup.
4570	6	?	white paper	?	No white paper bin found for this building. Refer to Note 14, Table 2.1

Bldg	Bin Size	Bin Location	Bin Type	% Full	Comments
4588	20		cardboard/wood (2)	120	These bins were located south of 4557 and 4558. One bin contained mainly wood, cardboard and PVC pipe. The second bin contained mainly metal scrap, piping, and pipe insulation.
	20		scrap metal (3)	100	
4610	6	South	white paper (1)	40	Also contained one sheet green engineer's paper and one sheet yellow legal sheet.
4612	2	South	scrap metal (3)	80	Also contained Styrofoam cups.
4619	20	South	cardboard/wood (2)	100	Also contained leaves, foam, A/C filters, newspaper, plastic, Styrofoam.
4640	8	?	scrap metal	?	Could not find this bin. See Note 9, Table 2.1.
4650	20	West	cardboard/wood (2)	100	Also contained rug, bag of general trash, metal pipe.
	20	West	scrap metal (3)	5	Also contained shirt and cardboard trash.
	4	West	scrap wire (4)	25	Also contained cardboard and glass.
4663	6	Southwest	white paper (1)	20	This bin had not been dumped for months. BFI was notified and service was resumed. Bin also contained one food wrapper, one brown paper wrapping.
4666	6	West	white paper (1)	95	This bin had not been dumped for months causing housekeeping to stockpile white paper in building. BFI was notified and service was resumed.
4705	20	West	Al Li (3)	25	Also contained a few paper towels.
	20	West	scrap metal (3)	50	Also contained a small amount of cardboard, foam, plastic and wire.
	2	West	Al scrap (3)	70	
	20	West	Al shavings (3)	10	Also contained a few paper towels and sandpaper.

Bldg	Bin Size	Bin Location	Bin Type	% Full	Comments
4707	20	East	cardboard/wood (2)	80	Also contained some foam and mixed trash.
	20	East	foam (5)	0	
	20	East	foam (5)	15	Brown paper attached to block foam.
	20	East	cardboard/box board (6)	40	Also contained one rag and some plastic film.
	6	East	white paper (1)	0	This bin was inspected on two separate dates and found empty both times.
4708	20	West	cardboard/wood (2)	100	Also contained some foam, plastic and paper (~10%).
	6	Northeast	white paper (1)	60	Also contained ~15% vellum, colored paper, two phone books, and box board.
4711	2	North	scrap metal (3)	60	
	2	North	Al plate (3)	80	
	2	North	Al shavings (3)	85	Also contained approximately 5% rubber hosing.
	4	North	Al Li (3)	60	
4728	2	South	scrap wire (4)	90	
4755	6	West	white paper (1)	50	Noticed one yellow post-it.
4777	20	North	wood (7)	0	This roll-off was covered and attached via pipe to a tank.
8023	20	North	cardboard/wood (2)	15	Also contained some plastic and metal.
8025	20	Southeast	cardboard/wood (2)	30	

1. Recyclables presently picked-up by BFI and hauled to their Huntsville plant. Refer to Section III.E, Table 3.4.
2. Roll-offs hauled to the Huntsville landfill by the MDI contractor.
3. Hauled to DRMO by the MDI contractor for processing and sale.

4. Scrap wire hauled to Building 8025 by the MDI contractor for processing and sale.
5. Foam hauled to the RSA inert landfill by the MDI contractor. [9]
6. This bin, upon the initial inspection, was found to contain foam. Normally, this building has three foam containers and one cardboard/wood container. [9]
7. This roll-off appears to be permanently in place.
8. Grass and leaves collected in this roll-off are taken to the RSA inert landfill. [7]
9. Per Mr. Hopkins of MDI, this container is temporarily in place here and is normally located at Building 8023 and is for cardboard/wood. [9]

## Summary of Findings

### Current Recyclables

Table 5 is a listing of the white paper, aluminum cans, and cardboard quantities picked-up by BFI and taken to their Huntsville plant for baling and shipping to mills and buyers. Quantities for over a three year period were obtained. [1] In addition, line graphs were constructed to indicate any overall increase or decrease or anomalies. As can be seen in Figure 16, aluminum can recycling was erratic month to month. Figure 14 shows a small overall increase in quantities from 1991/1992 to 1992/1993 and an overall decrease from 1992/1993 to 1993/1994. It appears that 1994/1995 will be lower yet. One explanation for this decrease was a small attrition in employment. Also, there have been efforts to minimize paper usage. It's now standard practice to make double-sided copies for multi-page reports. [7] This plus the increasing popularity of e-mail has reduced paper usage. The cardboard collection follows the same overall pattern as the white paper with the exception of a large spike in February and March of 1993. It was during this time that around 800 employees were being moved into the newly constructed 4203 Building. The designated cardboard bin was relocated to this site. The movers used cardboard boxes for the relocation until the boxes were no longer serviceable, at which time they were discarded into the recycle bin. [7]

Table 5 gives an average of tons per year. In addition, averages per year have been computed and are listed below, to give a clearer picture as to whether collections are tending up or down:.

<u>DATES</u>	<u>WHITE LEDGER</u> (Tons)	<u>UBC</u> (lbs.)	<u>OCC</u> (Tons)
7/91 - 6/92	33.2	1104.2	1.2
7/92 - 6/93	37.5	954.2	3.0
7/93 - 6/94	30.9	1223.0	2.4

Table 6 is a listing of scrap metal quantities taken to DRMO for processing and sales to scrap metal dealers. These bins are monitored by MDI and are emptied when full. The MDI contractor keeps a log of trips. [9] The trip information is contained in Table 6. DRMO [21] provided a listing of the scrap metal that was turned into them by MSFC for the last six months. (They only retain six months of records on their computer.) They segregate this material into eight separate categories or bays. Thus their listing does not match that of MDI. Even so, all scrap metal they have received from MSFC is included in one of these eight categories with the exception of some minor, incidental, metal composites that had to be broken down or items they located themselves. When a bay becomes full, DRMO will place an ad in a national sale roster; therefore, all scrap metal is sold on a nationwide basis. Insulated wire is sold, by the tub or hopper, in local sales.

Table 5. MSFC Recycling Quantities

	WHITE LEDGER	ALUMINUM CANS	CARDBOARD
<u>DATE</u>	<u>(tons)</u>	<u>(pounds)</u>	<u>(tons)</u>
*Nov 89 thru Jun 91	235.74	0	0
Jul-91	19.1	1510	0.575
Aug-91	37.43	460	1.58
Sep-91	37.22	380	2.77
Oct-91	34.05	740	0.85
Nov-91	29.77	320	1.18
Dec-91	32.04	920	1.9
Jan-92	40.8	1020	1.07
Feb-92	31.19	1900	1.42
Mar-92	33.63	1300	1.14
Apr-92	31.165	1280	0
May-92	29.77	1700	1.11
Jun-92	41.94	1720	0.23
Jul-92	41.16	1260	1.76
Aug-92	38.28	1000	2.55
Sep-92	40.72	1840	2.29
Oct-92	43.175	1340	1.25
Nov-92	47.13	370	2.56
Dec-92	36.27	800	0.62
Jan-93	28.985	1180	0.59
Feb-93	33.428	820	8.85
Mar-93	42.757	720	7.74
Apr-93	36.63	300	2.53
May-93	33.29	960	2.71
Jun-93	28.45	860	2.7
Jul-93	27.93	1140	4.02
Aug-93	34.92	1866	2.76
Sep-93	24.46	740	2.24
Oct-93	28.1	800	2.53
Nov-93	37.64	880	4.36
Dec-93	34.46	1300	2.13
Jan-94	22.5	880	3.23
Feb-94	33.3	920	1.17
Mar-94	30.94	1100	1.19
Apr-94	39.25	880	1.36
May-94	28.06	1170	1.98
Jun-94	29.82	820	1.64
Jul-94	26.71	1160	2.76
Aug-94	30.98	860	2.72
Sep-94	26.52	1880	1.51
TOTALS	1303.94	41096	85.575
Ave. tons per annum	401.2	9.5	39
Ave. tons per month	33.43	0.8	3.25

\*Not included in totals.



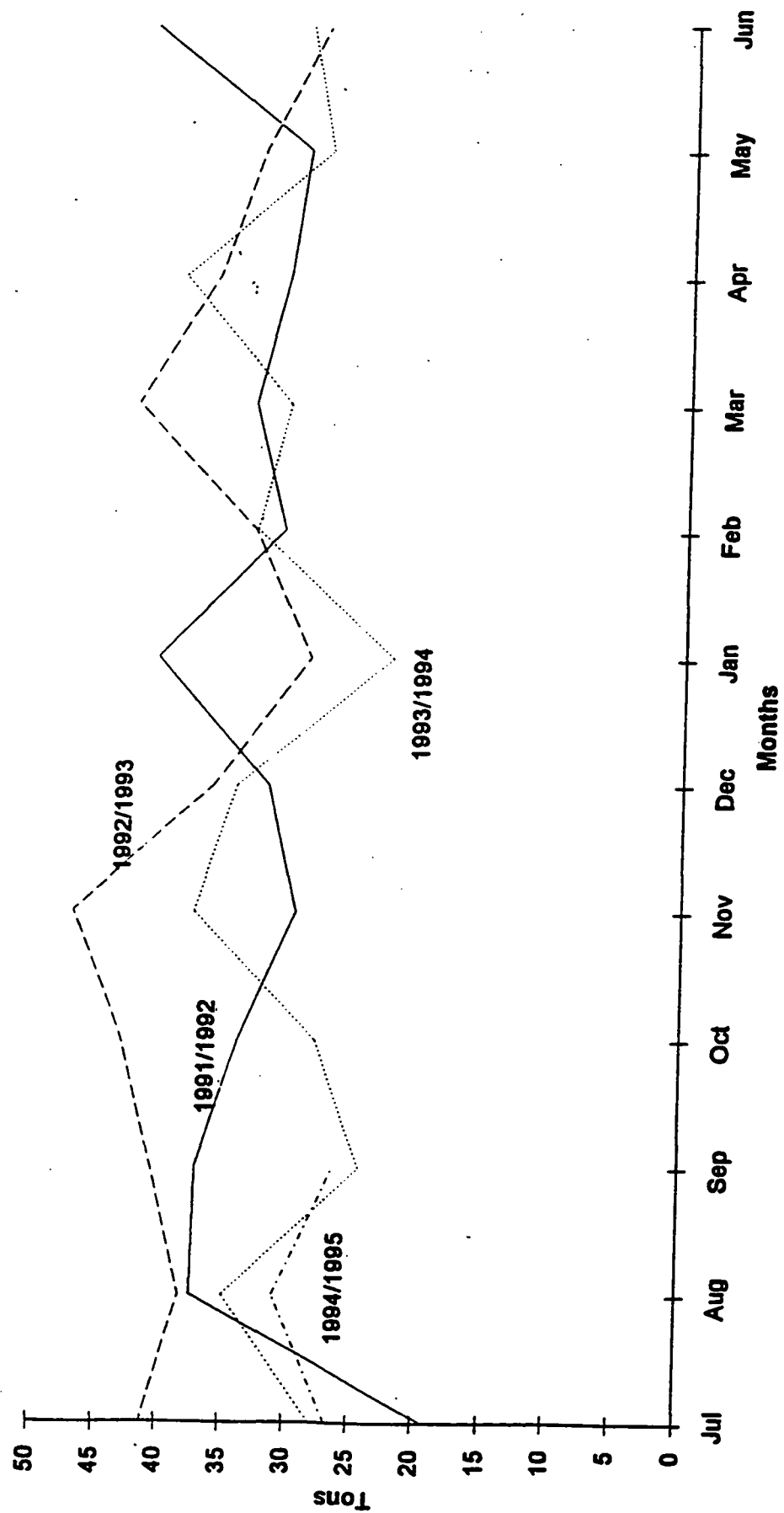


Figure 14. MSFC White Ledger Paper Recycling Quantities

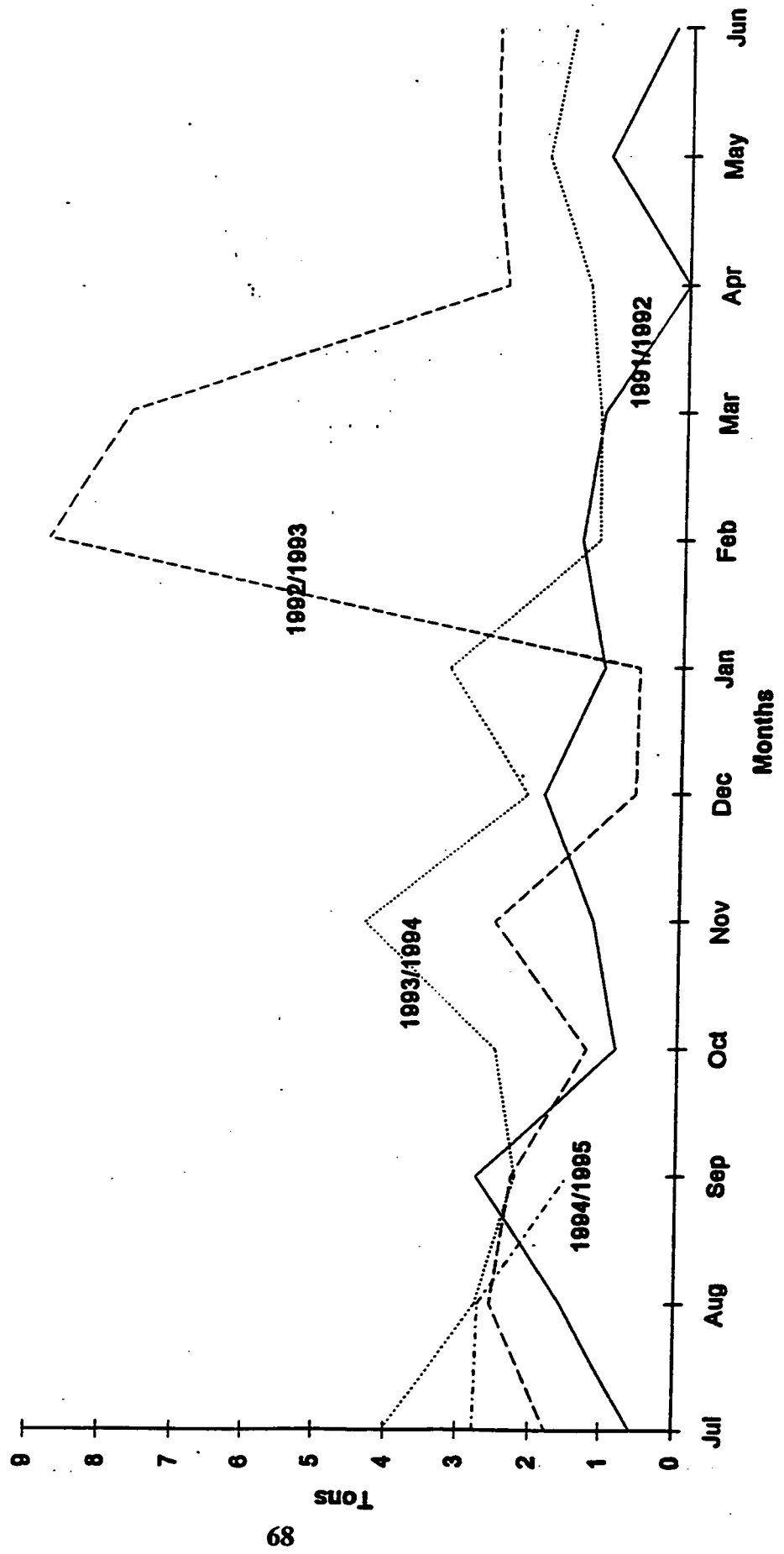


Figure 15. MSFC Corrugated Cardboard Recycling Quantities

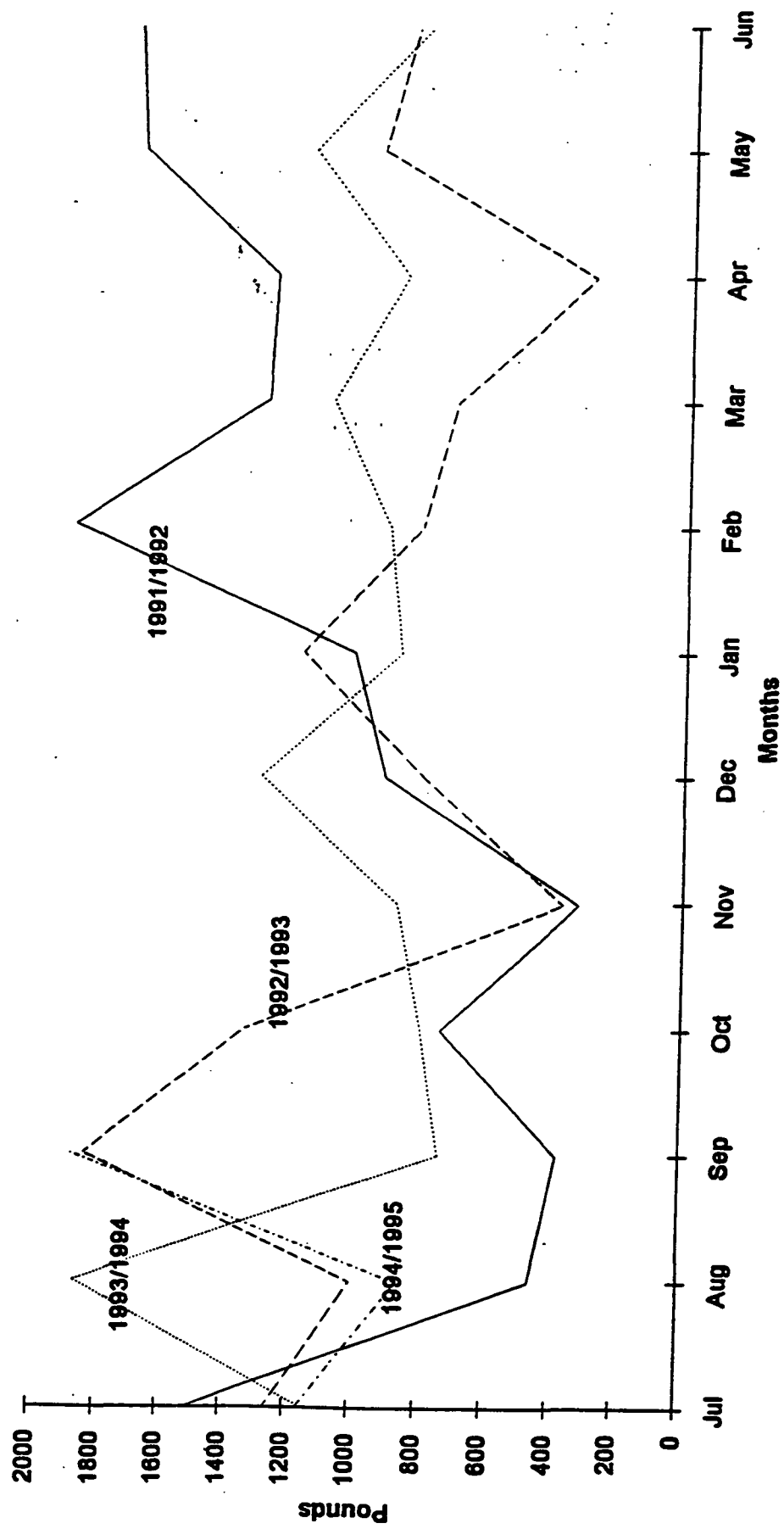


Figure 16. MSFC Aluminum Can Recycling Quantities

**Table 6. MSFC Recycling Quantities - Scrap Metal and Wire**

**a. Quantities Obtained from MDI.**

BLDG	BIN SIZE	COMMODITY	AVERAGE TRIPS/MO	APPROX CU YDS/MO	APPROX CU YDS/YR
4588	20	scrap metal	2	40	480
4612	2	scrap metal	4 times /yr	0.67	8
4650	20	scrap metal	2	40	480
	4	scrap wire	6 times/yr	2	24
4705	20	Al shavings	1	20	240
	20	Al Li	1	20	240
	20	scrap metal	2	40	480
	2	Al scrap		5	60
4711	2	Al plate	2	1	12
	2	Al shavings	2.5 ave.	5	60
	2	Scrap metal	6 times/yr	1	12
	4	Al Li	2.5 ave.	10	120
4728	2	scrap wire	2	4	480

\*\*\*\*\*

**b. Quantities Obtained from DRMO.**

COMMODITY	POUNDS/6 MO	APPROXIMATE TONS/YR
E1K (Light steel that is baled.)	119,000	120
Al Li Solid Pieces	480	0.5
Al Li Borings and Turnings	3,700	4
Regular Irony Aluminum (~90% Al with some iron)	13,240	13
Heavy Steel	165,000	165
Mixed Metal	12,900	13
Light Steel	2,500	2.5
Wire	8,100	8

Surplus equipment and supplies are processed through Building 8025. No records are maintained of the items received or of their final disposition. [15,16]. Records are kept of the proceeds received from auctions. There are three to four sales per year. The last sale garnered \$92,000, which was considered to be larger than normal. [16] Based on this, it was estimated that the proceeds would range between \$200,000 to \$350,000 per year. (More specific information was not available.)

### Potential Recyclables

Table 7 gives yearly tonnage of the MSFC waste stream with disposal destination. The footnotes list the sources from which the information was obtained or explains how it was computed.

Table 8 is a listing and quantification of specific items present in the waste stream. Referring to the visual sort data, Table 2, four components appear to have (additional) recycle potential: mixed office paper, corrugated cardboard, newspaper, and brown paper restroom towels (as compost). From the manual sort data, were added aluminum cans and magazines. It was decided not to include certain categories: glass, rigid plastic, box board, food stuff, and steel cans. This is not to say that these items do not have recycle potential. Rather, it was felt that the data collected under this part of the contract does not give an accurate indication of quantities present in the waste stream. These items are mainly food service wastes and are discussed in a separate report. Also film plastic was not included. Although it is felt that "sort" quantities were representative of total waste stream, this commodity would not be considered a recyclable. The film was in the form of bags used to collect building trash and would be too contaminated for effective recycling. From the manual sort, it was also evident that most of the mixed paper in the solid waste stream is composed of paper that can be recycled as white ledger stock (13.6 percent of a total 18.1 percent). Therefore, a total of eight categories were considered for potential additional or new recycling. Others could possibly be recycled at specific locations only.

The column in Table 8 labeled "absolute quantity" is based on quantities present. From Table 3, the percentages of these commodities by weight were multiplied by the total refuse bin tonnage (1260 tons/year--Table 7) to obtain a yearly tonnage that could potentially be recycled. Then these amounts were multiplied by various capture rates to give a "realistic quantity" or an estimate of additional quantities that MSFC can reasonably expect to achieve. The capture rates were based on literature (see Section 1), engineering judgment, plus MSFC's current practices. The capture rates used were 70 percent for paper, 70 percent for OCC, 70 percent for aluminum cans, 85 percent for restroom paper towels, 100 percent for shredded paper, and 35 percent for magazines.

**Table 7. MSFC Waste Stream and Disposal Quantities**

<b>DISPOSAL DESTINATION</b>	<b>COMPUTED AMOUNT</b>	<b>YEARLY AMOUNT</b>
Huntsville Incinerator (1)	1156 Tons/11 months	<sup>1260</sup> ~ <del>1280</del> Tons/year
RSA Inert Landfill		
Foam (2)	~140 cubic yards/ month	~1680 cubic yards/year
MSA-3 (2)	~ 20 cubic yards/month	~ 240 cubic yards/year
Grass and leaves	(?)	
Huntsville Landfill (3)	28.8 tons/3 weeks	~500 tons/year

1. This includes all bin refuse hauled in MDI truck 007 (front-end loader). The tonnage was computed by tallying "truck" receipts for February - December 1994.
2. This is the foam from Building 4707. MSA-3 is a special type of foam material, also from this building. (Note: It was learned that MSFC now uses a new type of foam: MCC-1 manufactured on-site. [141] These bins are monitored by the MDI contractor and emptied when full. Estimates of cubic yards were computed from trips/month obtained from the MDI contractor who keeps a record of trips. [9]
3. This refuse consists of the roll-off bins with the exception of those used to contain recyclable metal (refer to Table 3.5), foam, and grass and leaves. This bins are monitored by the MDI contractor and emptied when full. The tonnage was computed from "truck" receipts giving box number, date and tare weights. There are nine such refuse containers (refer to Table 3.3). The bulk of the refuse contained therein consists of cardboard and wood. (Although the contents would vary somewhat from bin to bin, on average, they contain 50% wood, 30% cardboard, with 20% metal and other miscellaneous. [9]) Refer to Part II for specific wood quantities. Only receipts since January 1995 were available. Information was requested from the previous contractor but was not provided.

**Table 8. Potentially New Recyclables from Current Waste Stream**

<b>COMMODITY</b>	<b>EST. YEARLY AMT. (Absolute Quantity)</b>	<b>EST. YEARLY AMT. (Realistic Quantity)</b>
Mixed Office Paper (1)	232 tons	162
White Ledger Paper (1)	174 tons	122
Aluminum Cans (1)	20 tons	14
Newspaper (1)	77 tons	54
Restroom Towels (1)	59 tons	50
Corrugated Cardboard		96
Refuse Bins (1)	137 tons	
Roll-Offs (2)	11 tons	8
Shredded Paper (3)	26 tons	26
Magazines (1)	83 tons	29

1. Quantities for these commodities were computed from the volumes found via the manual sort for the six refuse bins by taking percentages of each commodity (by weight) times overall yearly tonnage.
2. Quantities for these commodities were computed from estimate of percent volume, on average, that these items constitute of the total roll-off bin containers--50% wood and 30% cardboard--times the container fill rate per month. [9] A conservative density of 8 lbs/cu yd was used for unflattened cardboard.
3. Quantity obtained from Mr. Mike Wilson [7], based on January - December 1994 amounts.

## Comparison of Data

### Visual Versus Manual Sorts

Table 9 shows a comparison of the manual and visual sorts. The six bins that were hand sorted were also visually inspected. Initial visual sort data (visual - 1) for four of these bins were taken from Table 3.1. They were then reinspected a second time. However, for two buildings, 4250 and 4471, it was necessary to perform two additional visual inspections as it was unclear which of the building bins had been delivered for hand sorting. Once the precise bins had been identified [9], they were then visually inspected on two separate occasions.

It was originally hoped that a conversion could be made from percent volume to percent weight to give a more meaningful comparison, using appropriate density figures. Unfortunately, the density figures computed were in obvious error (refer to Section 6) rendering this pointless.

Both the visual and manual sorts indicated computer paper to be in such small quantities, that this commodity was not included on the table. The manual sort had five additional categories; it would not have been feasible to break the visual sort into that many categories. Therefore, certain "manual" categories were combined. The mixed office paper reported for the manual sort on Table 3.8 includes both white and colored paper. Food and drink waste on Table 3.8 consists of food stuffs, aluminum (most aluminum was in the form of beverage cans or tin foil used to wrap food), glass (most glass was in the form of beverage bottles), steel cans, and that portion of the "other" category in the manual sort that consisted of food and drink waste.

This type of comparison can only be used to indicate obvious anomalies in the visual sort. For example, OCC could comprise a large section of a bin by volume and be relatively low in weight percentage as almost all cardboard boxes are deposited in the bins unflattened. The opposite would be true of magazines: high weight-to-volume ratio. Therefore, trying to compare the volume and weight percentages of the different commodities is futile. However, it does indicate that the visual sort was not an accurate indication of the presence or quantity of magazines. This was also true for aluminum cans. Both these items are hard to spot intermingled with office trash. This discrepancy in magazines is indicated on the table for Buildings 4203, 4250, 4666, and 4705. Office paper, corrugated cardboard, film plastic, food and drink waste, restroom towels and newspapers were thought to be fairly easy to spot visually. Almost all trash was deposited in clear plastic bags. However, film plastic weighs very little; therefore, as indicated by the table, a high volume percentage would result in a low percentage by weight.

A better check of the accuracy of the visual inspection sort would have been to make a sort of each bin visually before it was hand sorted. Unfortunately, this was overlooked. (See Section 6.) Only the percent full of each bin was noted.



Table 9. Comparison of Manual and Visual Sorts (1)

Bldg	Mixed Office Paper	Corrugated Cardboard	Film Plastic	Food & Drink Waste	RR Towels	Magazines	Newspaper
4203							
Manual	158	5	8	98.25	27.5	26.25	39
% wt	40.2	1.3	2	25	7	6.7	10
Visual - 1	10	15	5	40	20	0	10
Visual - 2	20	5	15	25	10	0	10
4250							
Manual	63.5	24	9.5	145	20	34.5	27.5
% wt:	17.7	6.7	2.6	40.3	5.6	9.6	7.6
Visual - 1	50	5	28	10	0	5	0
Visual - 2	50	10	5	15	10	0	5
4471							
Manual	10	68.5	12.75	82.5	2.5	1.5	3
% wt:	4.5	31	5.7	37.2	1.1	0.7	1.4
Visual - 1	10	5	15	30	10	0	0
Visual - 2	0	25	5	55	10	0	2
4666							
Manual	13.25	>0.5	5.75	19	12.25	13.5	4.25
% wt:	13.7	~0	5.9	19.6	12.6	13.9	4.4
Visual - 1	35	10	25	10	20	0	0
% vol:	25	5	20	30	20	0	0
4705							
Manual	37	56	12	198.8	9	27	18.5
% wt:	8.3	12.6	2.7	44.7	2	6.1	4.2
Visual - 1	5	20	15	40	20	0	0
Visual - 2	10	0	10	25	40	0	15

Bldg		Mixed Office Paper	Corrugated Cardboard	Film Plastic	Food & Drink Waste	RR Towels	Magazines	Newspaper
4708								
Manual	weight:	4	15	1.5	8	1.5	>0.5	2.5
Visual - 1	% wt:	6.6	24.9	2.5	13.3	2.5	~0	4.1
Visual - 2	% vol:	0	30	10	60	0	0	0
	% vol:	0	45	20	35	0	0	0

1. For the manual sorts above, mixed office paper consisted of white and colored paper. For food and drink waste, the "manual" categories of food stuffs, aluminum, glass, steel cans, and that portion of "other" consisting of food and drink waste were combined.

## Findings Versus Published Data

Paper accounts for 40 percent of all solid waste and 77 percent of government office waste, according to a White House statement issued at the signing of the October 20, 1993 Executive Order requiring all federal purchases of printing and writing paper containing 20% post-consumer material. The U.S. government uses 300,000 tons per year of printing and writing paper, approximately 2 percent of the total market. [92] (The American Paper Institute estimates that as much as 85 percent of an office building's waste stream by weight is high-grade recyclable paper. [18]) The waste composition of a commercial waste stream in Fullerton, CA [91] indicated 42.06 percent by weight of paper (corrugated, mixed, newspaper, ledger and other paper). (It also indicated 7.7 percent plastics (hard and film), 3.15 percent glass, 9.48 percent metals, 9.57 percent yard wastes, and 12.61 percent of other organics (food waste, tire/rubber products, wood, and manure). [91])

Per Reference 77, it was suggested one assume a generation rate of 0.5 pounds white ledger per employee per day for general offices, with a 60-70 percent recovery rate. Reference 12 obtained from MSFC, contains a summary of "personnel requiring office space" of 5,960. Therefore, this computes to 2,980 pounds per day of white ledger generated or approximately 393 tons per annum. Adding the present amount being recycled of 401 tons (Table 5) to the waste amount of 174 tons equals 575 tons. Since the present amount being recycled (as obtained from BFI) is 1 1/2 times the value assumed as being typical, one can only conclude that MSFC office employees generate considerably more than the typical office worker; in fact, almost double.

## Review of Sampling Procedures

This section gives an overview of sampling procedures described in various manuals and books. The actual approach used and the reason why it was chosen was previously covered.

Per Reference 69, there are three basic methods of waste stream analyses: 1) waste stream sampling/sorting/weighing, 2) field surveillance or visually estimating the volume for each selected category of waste and then multiplying volume by density factors, and 3) combining field surveillance with scalehouse data to estimate percentages of substreams. Field surveillance is considered to be well suited for commercial or industrial waste when the loads are homogenous in nature.

Reference 77 details a waste composition sampling procedure. First one is to separate a representative mixed waste sample of about 50 pounds. Next the sample is to be weighed and the volume estimated. The density is to be computed. Next the sample is to be divided into components, the separate components weighed and the percentage of total weight that this component constitutes is to be computed. By multiplying the average density and composition of the cubic yards disposed of each month will yield an estimate of total monthly solid waste generation. Using composition percentages, the total can be broken down into individual material groups. [77]

Reference 18 states that in order to achieve a complete understanding of the waste stream, one must determine how much waste is being generated and where it is coming from, as well as what it is made up of. It states that sampling must provide for seasonal and geographical fluctuations. It also states that waste composition programs must provide information on waste flow by generator type. Preplanning must include understanding study objectives and knowledge of facility operations including identification and quantification of incoming waste, routes, scheduling, and hauler information. The reference gives a layout for sorting activities and a procedure for manual sorting including laboratory analysis to determine heating value or elemental analysis, if desired. Per the reference, a visual inspection, although not as reliable as the manual sorting process, is a recommended addition. Two phases of visual study are given: a hauler interview and waste characterization via observation of waste as it is discharged.

The reference also discusses alternate methods of characterizing commercial waste other than traditional manual sorting. One such method consists of reviewing available information from waste composition studies conducted within other regions of the U.S, conducting surveys of the commercial business community, conducting limited sampling and conducting interviews of private haulers. One county in New York state used this approach to characterize their commercial waste stream. Generation rates per square foot of occupied floor space were chosen as the variable to estimated waste production, since it was stated that commercial waste is generally a function of the type of business and not necessarily number of employees. In addition, the criteria used to establish reasonableness in the waste quantity determination was the selection of an estimate which could be supported by at least two other estimating methods such as interviews with waste haulers and generators. [18]

An article in BioCycle [91], discusses a waste study conducted in Fullerton, CA. The residential, commercial and industrial waste generators were divided into nine subpopulations. Random samples were collected from each subpopulation. Samples were sorted into eight waste categories, and these were further subdivided into 36 types. The sampling program was divided into three seasons to account for seasonal variations. For commercial and industrial streams, samples were collected from randomly selected generators in three cubic yard bins. Selected bins were then hand sorted. Characterization of wastes in roll-off containers began with an initial visual assessment. If the contents were relatively homogeneous, the load was dumped, surveyed to estimate the percent of the waste types. In cases where wastes were mixed or where it was not possible to visually discern the contents, the container was taken to a transfer station and unloaded. A subsample was then extracted and hand sorted. [91]

ASTM Standards, Draft Number 2, October 21, 1988, "Method for Determination of the Composition of Unprocessed Municipal Solid Waste" provides proposed procedures for measuring the composition of MSW by manual sorting. [18] This method allows the user to estimate the mean composition of solid waste based on sorting of samples over a period of time, usually 1 or 2 weeks. During the waste stream characterization, sorting samples,

which are approximately 200 to 300 pound portions of a solid waste disposal vehicle load, determined to be representative of the entire load, are taken and manually sorted into the various waste components. The number of sorting samples required to achieve the level of confidence desired so that the samples are representative of the entire solid waste stream is a function of the solid waste constituency. The proposed ASTM equation for determining the number of samples n is:

$$n = (ts/ex)^2$$

where t is the Student t characteristic that corresponds to the desired level of confidence, s is the estimated standard deviation, x is the estimated mean, and e is the precision value. Since the number of samples varies by component, the sample size is controlled by the component from which the total number of samples to be taken was derived. If sorting for four components, n would be computed for each component with the largest n dictating sample size. [18]

The proposed standard lists t values as a function of the number of samples and confidence intervals of 90% and 95%. The standard also lists values of mean x and of standard deviation s based on field test data for MSW samples during weekly sampling periods at several locations around the U.S. This procedure is iterative. For example, the standard deviation for mixed paper is given as 0.05, with a mean of 0.22. A sample size of 10 is selected with a desired confidence level of 90% and a precision of 20 percent. Per the standard, t is 1.833. Therefore, solving for the number of samples, n equals 4.34. Picking an n of 5 yields 5.86. Picking an n of 6 yields 5.24. Therefore a sample of 6 will yield a 90% confidence level. These steps are then repeated for each component to be measured, with the largest n determining number of samples. This procedure, because it is based on municipal solid waste streams or combination residential, commercial and industrial waste is not applicable to this study; that is the standard deviations and means would not apply, as commercial waste streams typically consist of large fractions of recyclable materials. [18]

## **Section 4**

### **Surveys**

#### **Summary of Employee Survey**

During the latter part of December 1994, twenty employees from nine buildings and of varying occupations were interviewed. They were asked to evaluate the present MSFC recycling program and to suggest ways/ideas for improvement. As one or more questions per survey elicited unique responses, and because it was felt that the MSFC Facilities Office who commissioned this study would find the actual responses interesting and informative, it was decided to include the actual surveys--questions and responses--in the report (Appendix A).

All twenty employees were aware of the recycling program and participate in it, some more diligently than others. Only one individual did not have a white paper bin, even though this individual did recycle her white paper by putting it into another bin. Three individuals felt that the bins for the aluminum cans were not conveniently located, making them remiss in recycling them. Most of the respondents did not know who to contact if they had a question, problem, or suggestion for improvement, but no one felt this was cause for concern; i.e., if the need arose, they could find out with minimal effort. Most participants were not aware that white post-its are available, but all knew to remove the yellow post-its before placing their white paper in the recycle bin. Removing the post-its was not considered an inconvenience. The employees were split concerning the need for education. Some felt education is needed for new employees only or if there is a change in the program. Others felt a need to educate people concerning the broader consequences of not recycling. One individual thought it would be beneficial to provide recycling information for those employees that wish to do more than curbside or county drop-off centers provide. These and other practical suggestions have been included in Section 6.

#### **Summary of Company Survey**

Six local companies and four out-of-town government installations were contacted to query their recycling coordinators about the recycling programs in place at their companies/organizations. The survey indicated various level of recycling involvement in terms of number of commodities collected as well as level of participation. There are recyclables common to all the companies. For example all collect paper, but not all recycle the same grade. All recycle aluminum cans. However, at one company, this is done entirely by the employees. [112]

Only one of the ten contacted reported mandatory recycling. It also reported the highest (95 percent) participation rate. However, of the remaining nine voluntary programs, only one reported poor participation (as low as 30 percent).

Many of these companies stated that the return on their recycling investment was in the form of avoidance costs; the more they recycle, the less that needs landfilling, and thus tipping and hauling fees are reduced. In fact it is not unusual for these companies to donate part of their recycling proceeds to charity or to allow a local charity to collect and process a recyclable commodity. For one company "recycling" savings comes in the form of reduced custodial personnel. [113] A unique aspect of one of the programs was the use of free inmate labor. A more complete summary was not included here as detailed descriptions of these programs are included in Appendix B. Those aspects deemed applicable to MSFC have been included in "Discussion, Recommendations, and Conclusion."

## **Section 5**

### **Evaluation of an On-Site Processing Center**

One of the options to be considered in evaluating MSFC's waste and recycling programs is consideration of constructing a recyclable processing center on the Redstone Arsenal. By processing its own commodities, MSFC would garner 100 percent of the proceeds (in comparison with receiving a percentage of market value--their present contract with BFI). In return, MSFC would have to pay the capital cost of such a facility plus upkeep, maintenance, and the labor required to collect and process the recyclables. There are many forms that such a facility could take, as discussed below.

Generally, a contract that follows the market is advantageous to the seller. This has been especially true recently, due to dramatic increases in the prices of aluminum, cardboard, and white paper in the past few months. Therefore, a system that allows for flexibility and frequent bidding should garner the best prices. MSFC presently goes out for bid for its recyclables: white ledger paper, aluminum beverage cans, and old corrugated cardboard. The contract is presently held by BFI. It was signed July 1991, extending for three years, with two 1-year extensions. BFI provides the containers. They collect and transport the recyclable materials to their facility in Huntsville where they perform limited hand picking before baling the commodities and shipping to their buyers. It can be assumed that the bidding process ensures the best price for sale of loose commodities to local companies with minimum outlay by MSFC for equipment and labor. Therefore, no investigation into transferring this contract to other local buyers was done. .

### **Types of Waste Processing Facilities**

Historically, solid waste was collected in "packer" garbage trucks and delivered directly to landfills. The closing of landfills, the scarcity and increasing value of land space, and dwindling raw materials have given rise to recycling. Processing facilities developed in response to the need to handle the growing quantities of recyclables. These facilities serve the functions of a broker, collecting from several haulers and distributing to several markets. [18]

Several types of processing facilities have evolved. These facilities, defined in order of increasing complexity, are listed below. (Note: These definitions vary throughout the literature, and from one state agency to another. For example, there is considerable disagreement on what constitutes a MRF.)

**Drop-off Facility or Center** - These facilities accept materials, ensure that they are separated correctly and then send them to other processing facilities or to buyers or mills. They have no processing equipment. [18]

**Buy-back Center** - A drop-off center that pays for recyclables.[18]



**Intermediate Processing Center (IPC)** - These facilities have equipment for preparing material for markets by baling, crushing, and flattening, but no equipment for separation.[18]

**Materials Recovery Facility (MRF)** - A facility that receives commingled recyclables and has equipment for separating as well as equipment for preparing the materials for sale. [18] Most of these facilities separate items only, not fibers or parts of larger commodities. MRF's vary greatly on the amount of incoming materials which it sorts. [62] Generally there are two types of collection streams associated with MRF's: totally commingled in which all recyclables are collected in one container and source-separated commingled which is typically a two stream mix with glass, plastic and metal containers in one stream and papers in the other. [63] A MRF might divert between 10 and 25 percent of the waste stream to recycling.[58]

**Mixed Waste Processing Facility (MWPF)** - A facility that receives unprocessed waste or raw garbage--there is no preparation or sorting of material by the generator--for removal of recyclables. (These facilities are sometimes titled "dirty" MRF's. [62]) MWPF's divert between 5 and 20 percent of the waste stream to recycling. [58]

(Note: A review of literature indicates the trend in the solid waste field is toward capturing more of the waste stream via technologically advance material recovery facilities, with fewer of the expensive mixed waste processing facilities. [57, 58, 59, 65] More private companies are becoming involved with the various types of MRF facilities. [58,60] There is also a trend toward joint ventures between such companies as scrap dealers and trash haulers, combining of source-separated MRF's with transfer stations to achieve economies of scale, and locating MRF's at disposal facilities. Combining source separation with mixed waste processing is a very effective way to achieve a high diversion rate.[58] MRF's and MWPF's can employ a host of sophisticated equipment: debaggers, glass crushers; metal can densifiers, crushers, blowers, magnetic separators, flatteners, and shredders; plastic sorters, granulators, shredders, and densifiers, paper, magazine, and cardboard shredders, including animal bedding equipment; wood chippers, shredders, and grinders; cable strippers; metal shears; sorting and separating conveyors. Research is also being done into automatic separation of paper by type, glass by color, and plastic by resin and color. [65,66])

#### **Type of Facility Selected for Consideration**

Per the direction of the COTR, this section of the contract was given low priority as the likelihood of constructing an on-site processing center is low with current funding for recycling. Therefore, only one type of facility was evaluated as a possible initial operational approach. Because there are little available funds to invest in such a center, it was decided to consider a low-technology intermediate processing center (IPC) with minimum investment required. (Using a low-technology approach, the capital cost is minimized, but the recovery is usually labor intensive although a small business contractor may find it profitable. This

approach enables the system to more readily respond to fluctuations, such as discontinuing collection of a commodity if the market price drops enough so it becomes uneconomical to collect and process it. [69] A high-technology system would be more capital intensive, relying more on mechanical equipment to process materials than on manual labor. It is estimated that only large-scale operation (10 tons or more) can justify costly high-tech equipment except for research and demonstration purposes. [18])

Proceeds received for products go up the more the source processes the commodities to fit the specifications of the buyer (broker, dealer, mill, foundry, or other end user). For example, more will be received if commodities are cleaned, baled, or flattened, are loaded by the facility or even transported to the buyer's dock. The more the buyer has to do, naturally, the less will be received by the MRF. The downside, is that the source must have process facilities to do this.

Although following a low technology approach tends to increase labor, it was thought that by augmenting the source separation system now in place, hand-picking and sorting would be minimized. The source-separation system would be augmented by increasing the number of buildings to act as collection points and to increase the number of building pick-ups.

Buyers that receive commodities from BFI buy in large quantities (by the truckload). Some require that commodities be baled, others accept gaylords: three foot high boxes that fit on 4-foot pallets. Also, shipping costs are such to preclude the need to compact or bale commodities. (Although there are many available markets for these products, it seemed logical to assume that BFI would be selling to those buyers that provide them with the highest overall price, subtracting for transportation.)

Tours were made of three local processing centers: 1)Huntsville Recycled Fiber, 2)South Central Recycling, and 3)BFI. All three could be considered low technology. The three centers are briefly described below. Also refer to the photographs contained in Appendix D of the report.

1. Huntsville Recycled Fiber is located on Wholesale Avenue in northeast Huntsville. The facility consists of one prefabricated metal building, with two small offices, plus an outside truck scale. Inside the building is one (sided) conveyor and one baler, purchased in 1979, a tipping area and a large area for temporary storing of bales. The center owns one semitruck for picking up recyclables in addition to roll-off bins that are collected and transported to the facility by BFI. The center is owned by Rock-Tennessee. The center buys cardboard, newspaper, office paper (white bond, white ledger, colored and computer grades) from local and area businesses and private individuals. Most of the commodities are sent to Rock-TN mills. [148]
2. South Central Recycling is located on Vermont Road SW in south Huntsville. (Photographs were not permitted of this facility.) The center consists of a prefabricated metal building with offices. One baler is located inside; a second one,

with an attached conveyor, is outside. This center processes white paper, general office paper, computer paper, aluminum cans, cardboard, limited film plastic, and soft covered books.

3. The BFI processing center is located on Commercial Drive NW in Huntsville. This facility is in a prefabricated metal building and includes a multi-story office and three-sided canopy under which is housed a cardboard/plastic baler. The facility has a can processing area located under a separate canopy. Plastic contaminants are picked out by hand. An electromagnet separates the tin and aluminum from steel cans. The cans are then crushed. There is an adjoining asphalt pad containing a certified truck scale, individual storage areas for loose recyclables, plus space of parking trucks, trailers and roll-off bins.

The proposed center for MSFC was patterned after 1. and 2., although these facilities have certain advantages over the proposed MSFC facility. They collect from a number of sources; they have the advantage of the economics of scale; larger quantities that justify expensive balers, fork lifts, trucks, and full time employees. Some would say they have the advantage of having this as their primary business; thus being current of the latest trends, technology, and prices.

The equipment for the on-site IPC was conservatively sized for processing maximum potentials. The size allows for storage space for stockpiling commodities until sufficient quantities are obtained for baling, plus room for stockpiling bales until a full truckload is attained. (Typical truck loads run from 40,000 to 48,000 pounds of material. [17] The industry standard for OCC is 45" x 45" x 50" bales, weighing approximately 980 pounds. For newspaper, the same size bales apply, but weighing approximately 1175 pounds. [18]) Refer to Table 10 for a materials list, specifications, and prices for the on-site IPF. Two configurations of recycle bins were selected for pricing. One would consist of four separate compartments, each one adjustable to accommodate varying volumes of commodities. The second type would consist of one compartment only, to be used, mainly for OCC. A hook lift loader that can be attached to the chassis of a standard 3/4 or one ton pick-up truck was specified for loading and unloading the bins. This device can pick up the bins, individually, transport them to the IPC, rotate and dump the contents on the floor of the IPC. It can then return the bins to their assigned building and unload them in place. The hoist can also be used to pull up and secure a flat bed unto the truck chassis allowing it to be used for general hauling. A multipurpose horizontal baler was selected for pricing. The baler is capable of accommodating cardboard, paper, or cans. However, most end users prefer cans flattened and loose. Therefore, a can crusher was also added to the materials list.

It should be noted that lower cost options that could be considered include renting the baler, procuring a fork lift attachment for use on an existing front-end loader, converting an existing building for use as the IPC, using blue collection bags in place of bins, collecting via an existing flat-bed truck, spreading cans in the IPC driveway for crushing, forgoing the IPC office.

Table 11 lists yearly amounts (original plus additional) recyclables, recent prices quoted for commodities, and location of markets. It should be noted that commodity prices can fluctuate dramatically month-to-month (see Section 1), and most have, in fact, been recently increasing.

Transportation costs from the on-site IPC to end users were obtained from Reference 17. Rates of local and long distance trucking companies indicates that rates are about \$1.00 to \$1.35 per round-trip mile, which includes 2 hours for loading and unloading. Location of potential buyers are given in Table 11 with the mileage to their plants or facilities in parenthesis.

If one considers white ledger only, MSFC currently receives 25% of market value for this commodity from BFL. At recent prices, MSFC stands to collect about \$250,000 from the sale of this item if it were to process it, versus \$62,000 from BFI or a difference of about \$188,000. Transportation costs are estimated at \$10,000. Gross operational and maintenance costs of operating MRF's were reported to average around \$53/ton with facilities having under 100 tons per day of throughput and around \$40/ton for those over 100 tons per day of throughput. [60] However, these figures would not be considered applicable here. Rather a cost of two full time employees, plus \$15,000 for O & M would be more appropriate. If this expense is conservatively estimated at \$80,000, a profit of \$100,000 would be realized on a return on investment of 33 percent.

#### Other Low Cost Ideas

There is an expanding market for small throughput MRF's, called mini-MRF's, or small MRF's--or SMRF's, geared toward lower-volume facilities. These systems process commingled materials with a minimum of labor. The process usually incorporates product size separation, magnetic separation of aluminum and steel, air separation of plastics, with a final visual inspection. They generally cost between \$75,000 and \$300,000, depending on equipment. [18] One such system, a scaled down version of a high technology MRF called a McMRF is manufactured by Count Recycling Systems. The standard design costs \$99,500 and can be added on to. However, even this scaled down version is capable of processing 10 to 20 tons per shift of commingled curbside residential waste. [60]

One article previewed a MRF at Miami University in Oxford, Ohio, showing how innovative thinking and bargain hunting produced a low cost recycling program.[61] The university has 16,000 students. A solid waste characterization analysis found that over 40 percent of the campus refuse was recyclable. Two approaches were adopted: MRF separation for the offices and source-separation for dorms. Source separation is done in residence halls in which students place paper, newspaper, beverage cans, plastic and glass in stacked bins. To process office waste, a MRF was constructed consisting of a 24 foot by 48 foot metal building. Adjacent to the building is a concrete loading dock. A conveyor system inside the building transports the waste through a series of sorting stations where personnel remove recyclable materials. (Note: In another article it was reported that the means of

**Table 10. Materials List for On-Site Intermediate Processing Center**

<b>ITEM</b>	<b>DESCRIPTION</b>	<b>COST</b>
<b>Prefabricated Metal Building [145]</b>	Size: 80 feet by 100 feet constructed on concrete pad. Two restrooms, one office (10 feet by 12 feet), both tiled, with HVAC. Building to have one personnel door and two 10 feet by 12 feet truck doors on front and side.	<b>\$120,000</b>
<b>Pick-Up Truck [105]</b>	One ton, cab and chassis only, white, V-8, 350cc, five speed.	<b>\$19,365</b>
<b>Hoist [135]</b>	Hook lift loader for loading recycling bins. Capable of unloading, rotating, and dumping bins. Also adaptable for loading flat bed.	<b>\$ 9,000</b>
<b>Can crusher [136]</b>	Bulk crusher of aluminum drink cans.	<b>\$ 4,000</b>
<b>Conveyor [137]</b>	Thirty feet, one level, flat top, slider bed, 31" wide, no side rails, travels at 60 feet/minute.	<b>\$ 2,900</b>
<b>Fork Lift [138]</b>	Double stack, standard fork.	<b>\$15,500</b>
<b>Horizontal Baler [139]</b>	Horizontal, high density, multi-purpose.	<b>\$26,000</b>
<b>Recycle Bins</b>	Four compartments, adjustable, 14 feet long. Cost \$4,000 each. [140] (1)	<b>\$120,000</b>
<b>Recycle Bins</b>	One compartment, \$2,500 each. (1)	<b>\$12,500</b>
<b>Office furniture and equipment</b>	One desk/ chair, four file cabinets, one PC with laser printer, miscellaneous office items	<b>\$5,000</b>
<b>TOTAL:</b>		<b><u>\$334,265</u></b>

1. Presently there are 95 MSFC buildings with refuse containers. However, many of these buildings are located close enough to be able to share recycle bins. The estimate is for 30 four-compartment bins and 5 one-compartment bins

Table 11. Expected Return on Recyclables for IPC

COMMODITY	AMOUNT PER ANNUM (Tons)	QUOTED PRICE	PROCEEDS (Dollars)	LOCATION OF BUYER/ MILES
[Mixed Paper (3)]	[162]	N/A (2)		Jacksonville, AL
White Ledger	724	\$350/ton [156]	253,400	Loudon, TN/200
Aluminum Cans	23.5	\$0.60/pound [157]	17,700	Huntsville, AL
OCC	143	\$105/ton [158]	28,200	Stevenson, AL /60
Glass:	N/A (1)	\$50/ton [159]		Atlanta, GA
Clear		\$25/ton [159]		
Brown		\$15/ton [159]		
Green				
HDPE	N/A	\$0.15/lb. [160]		Decatur, AL
PET	N/A	\$0.10/lb. [160]		Decatur, AL
Steel Cans N/A		N/A (2)		
Magazines	83	N/A (2)		
Newspaper	54	\$2/100 lb. [161]	2,160	Huntsville, AL

1. Quantities not available.
2. Local buyer for this commodity could not be located.
3. Mixed paper here also contains a portion of the white paper reported below.

sorting commingled containers should become more complicated as quantities increase. Between zero and five tons per day, the use of elevated or floor manual sorting is seldom cost-effective. For quantities above 15 tons per day, more automated, elevated systems become economically viable. [64]) The MRF includes a machine that sorts bimetal from aluminum beverage cans, compacting the aluminum. A baler is used for cardboard, HDPE and PET, and a high volume paper shredder processes newspaper and confidential paper. Most of the equipment at the MRF is secondhand and modified. The total cost for the MRF was \$102,909. A polystyrene recycling operation is located at a central meeting place for students. A parts washer from an automobile factory was reconditioned to wash plastic utensils and plates. A granulator was purchased to produce polystyrene flakes for resale. The recycling center is heated with used motor oil and waste hydraulic fluids from elevators. In addition to the residence bins and MRF, two converted beverage trailers are used as drop-off centers. The trailers contain eight bins on each side with roll up doors. Holes have been cut in each door to accept only specific recyclable materials; rubber flaps were placed over the holes to seal out moisture. Vending machines were modified to allow customers to use their own cups.

A second low cost MRF was built in Wilmington NC, a city with 50,000 residents. The MRF is a pole barn structure built for \$50,000. They use one ton flat bed trucks with portable bins to pick up recyclables. The MRF processes recyclable materials according to buyer specifications. Aluminum is flattened, glass crushed, plastic baled and newspaper compacted. Yard waste is composted at a site adjacent to the MRF where windrows are turned once a month with a front-end loader. [67]

A low tech approach to recycling, solid waste processing, and composting was used for a village (2,500 residents) in Vancouver Island. About five tons a week of MSW is generated half residential and half commercial. Residents put all metal, glass and plastic packaging and newsprint into blue bags, designating them as recyclables. All waste is taken to a recycling facility: a 80 feet by 160 feet prefabricated metal building with adjacent 60 feet by 160 feet composting facility. Two people work at the recycling center on a sorting carousel. Composting is done by an aerated static pile system. (A perforated pipe draws air through the compost pile facilitating breakdown and reducing order.) Capital costs for the plant, built in the early 1990's, were about \$1 million. [104]

## Section 6

### Discussion, Recommendations, and Conclusion

This section summarizes findings in literature on recycling products, practices, and programs. It includes practical suggestions and ideas which are felt to have potential for implementation at MSFC. It also includes ideas that were considered but were rejected as being too costly, having a poor return, or counter to employee productivity. The section concludes with a discussion on lessons learned in conducting this study

#### Review of Literature - What is Happening in the Recycling Industry

A review was made of newspaper, newsletters, books, and periodicals published within the last few years to discover some of the research, business practices, and production vis-à-vis recycled commodities presently being done. It was reported that over 2,000 domestic companies make new products from recycled materials, with forecasts for faster growth in the future. [31] Most of these recycling programs/ideas are not practical to implement at MSFC at this time. However, some of those reported are included here, along with the reference notations, to provide information of cutting-edge technology and current business practices.

1. Research is presently being done to recover plastics from scrap vehicles. Typically, it costs 11 to 55 cents per pound to recover plastics from autos. It costs about 30 cents to produce one pound of virgin resin. Currently less than 1 percent of all plastics from scrap cars is being recycled. Car manufacturers currently have pilot projects in the works for using recycled plastic to produce plastic car headliners and various reinforcements, plus projects involving recycling bumpers and bus seats. [26]
2. Certain residential curbside recycling programs have found profit in adding milk cartons and drink boxes to their recycling mix. In 1990, 500,000 milk cartons were generated. Milk cartons and drink boxes together comprise approximately 0.33 percent of municipal solid waste by weight. End markets for these materials range from \$90 per ton to \$150 per ton. [27]
3. A number of small entrepreneurial companies are using junk yard and scrap license plates, soda and food cans, bottle caps, tires, pop and beer caps, etc. to fashion belts, purses, bags, notebooks, backpacks and the like. (Possibly there could be potential to fashion space paraphernalia into similar quirky fashions.)
4. Used PET soda bottles are being remanufactured into carpeting, clothing, sleeping bags, and athletic shoes. Celanese uses recycled PET beverage containers to blend with virgin polyester to produce a fabric used in shopping bags, grocery totes, lunch bags, aprons, and briefcases. [30] A manufacturing company in New Hampshire



makes 100 percent recycled underwear from soda bottles. A company in California makes 34 products from recycled plastic bottles, including sweaters, jackets, hats, gloves, and other outdoor clothing. [40] A company in New Jersey makes high loft fiberfill for use in quilts from recycled PET fiber. [31] A manufacturing firm in Missouri makes flat and corrugated sheet, dimensional lumber, and molded products from scrap HDPE. [31]

5. A wood fiber company in Wisconsin repairs wood pallets. It processes over 5,000 pallets per week. A similar firm manufactures high added value products (such as home and office furnishings and jewelry boxes) from wood waste--old pallets and shipping dunnage. [31]
6. A company in South Carolina uses a pelletizing system to turn waxed corrugated scrap into fuel pellets. The pellets are reported to burn as efficiently as coal, produce less ash and discharge less sulfur and nitrous oxide into the atmosphere. [32]
7. A small buyer of recyclables located in Michigan collects scrap fiber from furniture manufacturers and shreds it into "shoddy." The shoddy is used as insulation in automobile door panels.
8. BellSouth Telecommunications now makes all of their customer bill envelopes from 100 percent recycled paper of which at least half comes from old telephone directories. [39]
9. A county in New Jersey has been recycling mixed paper (85 percent newspapers and 15 percent other paper) since 1982. (The county does not make a profit on the paper; this is done to keep it out of the landfill.) One of the firms the paper mix is sold to turns it into a variety of items such as construction fiberboard, sidewalk sheathing, roof and floor decks, insulating and decorative panels, expansion joints for concrete, and industrial packaging. [41]
10. A company in New Jersey has been manufacturing building products from 100 percent recycled newsprint since 1909. Their products include underlayment for carpeting and concrete construction, structural board for noise deadening, fire-proof roofing panels, insulation, subflooring and roof decking. It uses around 350 tons per day of recycled newsprint. [42]
11. An article in BioCycle previewed three businesses established in the last three years to process construction and demolition debris (C&D) and wood waste. One of the companies, which is located in Colorado, collects about 100 tons per day of C&D debris and yard waste. An initial market was a cogeneration power plant, until it shut down. Now the company sells wood chips to a fiberboard manufacturer, to a wastewater district which mixes the chips with Biosolids in an aerated windrow

composting operation. Low grade C&D that it receives is mixed with manure from a nearby dairy farmer and added to eight composting windrows at their site, each 300 to 400 feet long. Turning is done with a front-end loader, producing about 25,000 cubic yards annually. Additional wood chips are sold to the Colorado School of Mines which it processes with heat to produce a highly absorbent material for cleaning up oil spills.

A second wood recycler, in Massachusetts, processes C&D material, via a hammermill and a series of magnets and screens. Metals are sold to scrap dealers, aggregate rock and dirt is sold as fill, clean wood chips were sold to a cogeneration plant, but now go to a wood fiber plant that turns the chips into automobile door panels, fiberboard, and ceiling tiles. Both these companies charge a tipping fee, but it is considerably less than the local landfills, thus encouraging contractors to dump their C&D material at their facilities.

A company in New York manufactures a mobile processing unit for gypsum wallboard. (Construction of a 2,000 square foot home generates about 1.5 tons of wallboard.) Prime markets for the product are wallboard factories and agriculture. (Drywall has an effect similar to agricultural gypsum on soil properties.) [43]

12. The Institute for Self-Active Education launched a National Schools Recycle Network in 1981. Along with materials exchange centers in school gymnasiums and old warehouses in nearly a dozen states, this organization organizes workshops encouraging teachers to develop classroom uses for industrial waste products. A typical center has such items as colored paper, cellophane, wood scraps, plastic bottles, foam, wire, and punch-outs.
13. Possible uses for recycled glass include sandblasting metals, making stained and colored glass for the art market, and as a lubricant to take hot products out of molds. [46]
14. A company in Chicago recycles office furniture. The market for refurbished office furniture has been growing by 20 to 25 percent annually. This company disassembles and reassembles desks and chairs by hand. It gets from five to 25 semitrucks a week of old office furniture. About 5 percent of what they receive cannot be refurbished and is sold to scrap metal dealers. [49]

#### Ideas and Suggestions for Possible Implementation

MSFC already has in place an active and successful waste reduction and recycling program. The list of commodities they presently recycle, as given in Section 1, is commendable. Their program to capture used white paper; that is, supplying every employee with a separate white paper trash bin is optimal. MSFC has also instituted steps to not only reduce the waste stream and conserve resources, but to switch from products that cannot be recycled

to appropriate "recyclable" substitutes where possible. This includes purchasing white post-its and white legal pads to be used in place of colored ones, switching from blueline to photostatic copies for drawings, printing the in-house phone book on white paper only. In general, MSFC has been switching, as much as practical, from dyed to white paper supplies. Even more significantly is a proposal presently being considered to construct a recycling research and information center at MSFC. [7]

Proceeds from the sale of employee recycled commodities are returned to the employees; these funds are used to offset the cost of the company picnic. Per the present contract, the recycle program must, at least, break even, as there are no other funds available to support it. [7] The only proceeds that MSFC presently has at its disposal for its recycling program is from the sale of surplus items from Building 8025. It is estimated that the proceeds range between \$200,000 to \$350,000 from these auctions. Since funds are limited, improvements or new programs instituted at this time must, therefore, require little capital investment. Hopefully, proceeds garnered from modest improvements and fine tuning of the program now will yield added revenue that can be invested into more expensive and expansive options that will capture even more of the waste stream.

It is important that any suggestions not come at the expense of product efficiency, including research and intellectual pursuits in support of the Space Shuttle/Space Station programs. Approximately 7,281 individuals [12] are employed at MSFC, with an estimated 50 percent of those (NASA or contract personnel) being scientists and engineers. [7]

Review of literature and conversations with experts on recycling revealed a number of salient points that should be considered before implementing any suggestion. Of primary importance, before collecting or processing a product for recycling, is to have a market. A lack of markets for recycled materials is the greatest barrier to increased recycling in the country. The second largest barrier cited is the high cost of collecting recyclables. Other barriers listed in order of severity include: inadequate market prices for recyclables; processing costs; transportation cost; the need for additional public education; and low recyclability of products or low participation rates. [44, 48] A number of sources were revealed during the study as contacts for possible markets or as providing information on possible markets. Specifically, refer to References 113, (National Recycling Coalition of Washington DC), 111, 47, 142. and 147.

A nationwide public opinion poll revealed why some people do not participate in recycling: thirty percent said it takes too much time; nineteen percent asked, "Why should I?"; twelve percent said they didn't know how; eight percent said it was too messy; another eight percent said it was because curbside collection was not provided; 23 percent cited other reasons. [18]

Motivation in general can be influenced by a number of factors: the credibility of a source of information or request; the context in which information is delivered; the frequency with which information is delivered; the relativity of a request for action; the degree to which

an incentive is social or monetary in nature; and the extent to which an individual is already attitudinally disposed to a desired behavior. [18]

One of the most important factors underlying conservation behavior is an individual's ability to identify a reasonable justification for such behavior. Studies suggest that an individual's sense of community involvement can play an important role in motivation. Therefore, messages that depict a dual appeal (individual and community) may be more effective. Many people recycle because they consider it an environmental responsibility; i.e., they are intrinsically motivated. Others need monetary reward, prizes or other extrinsic motivation. (On criticism of extrinsic incentives is that once the incentive is withdrawn, the increase in recycling may cease.) Studies have found that involvement with a conservation activity can be seen as satisfying in its own right. It is also thought that individuals are more likely to respond when they believe others are participating in the same or similar activity. [18]

The implementation of mandatory recycling has offered mixed results. Research has found that attempts to mandate behavior change through disincentives and punishments frequently elicit negative attitudes. [18] A survey showed a higher participating rate (70 percent) in one California city where participation was not mandatory than in a New York city (30 percent) where participation was mandatory. [18]

Having containers provided seems unequivocally to increase participation. In one city, residents supplied with containers had participation rates of 50, 75, and 85 percent. For those routes without containers, participation was only 25 percent. [18] When AT&T in New Jersey started their paper recycling program, each employee was given a folder. When it was full, they were expected to take the paper to a central recycling bin. Unfortunately many of the employees were not making the trip to the bin. An extra receptacle was placed at each desk and paper recovery doubled. [50]

A general observation made as a result of the visual and manual sorts of this study: the easier it is to recycle, the higher the participation. Participation was high for white paper (as each employee has a recycle bin at his/her desk), less so for aluminum cans( each employee must walk to the nearest bin to dispose of his/her used beverage cans), and relatively low for cardboard (the site has only one bin designated for used corrugated cardboard). (Reference 18 talks about the optimal degree of residential source separation. Theoretically, dozens of categories of waste could be source separated. As a general rule, it was found that the less residents have to do to participate the more likely they are to participate, However, the responsibility of sorting into categories will not be the overriding consideration in the decision to participate. For residential programs, it was found that four containers can effectively separate 70 percent of household refuse.)

## Viable Ideas and Suggestions

Following is a list of recommendations, ideas, and suggestions as a result of observations made during the study, from the employee and company surveys, from a review of current literature, from conversations with those employed at MSFC and others involved in solid waste reduction and recycling. The recommendations are in no particular order. Where feasible (and within the scope of the study), reduction in the waste stream and monetary gains to be derived from implementing the suggestions have been included. The particulars of implementing the suggestions have not been included. The option of constructing an on-site IPC for the purpose of processing the recyclables on-site has been include in Section 5. Some office waste may be suitable only for composting.

1. A number of bins were found to be empty on two visual inspections conducted during the study. In addition, Mr. Rick Hopkins of MDI, indicated those these bins are normally empty or generally contain little refuse (10 percent or less). These bins are (refer also to Table 2):

<u>Bldg. No.</u>	<u>Bin Location</u>	<u>Size (cu yds)</u>	<u>Collection (days/wk)</u>
4189	north	2	2
4207	north	6	3
4471	north	6	5
4471	south	6	5
4471	south	2	5
4487	northwest	2	5
4551	south	2	1
4582	east	8	1
4626	south	6	1
4671	east	2	5
Archery Club	south	2	1

In addition, it was also mentioned by the building manager that the bin for Building 4498 (8 cubic yards) could be removed or relocated to another building. This building (actually three metal Quonset hut sheds) is no longer used. Garbage contained in this bin is the result of drive-by drop-offs.

Although removal of these bins, reducing their size or reducing their scheduled pickups may not reduce MSFC utility costs (MSFC pays the same regardless of amount of trash taken to the Huntsville incinerator, as long as the maximum is not exceeded), it may result in cost savings on the collection/hauling contract.

2. It is recommended that more of the old corrugated cardboard throwaways be captured from the waste stream. Table 3.7 lists 104 tons of (realistically) potentially recyclable cardboard. Using a computed value of 0.95 [2] times a price of \$105/ton

[108] results in a potential amount \$10,400/year. It is recommended that initial efforts be concentrated at those buildings/bins that were found to have the largest percentage of this commodity. This includes, from conversation with Mr. Rick Hopkins [9]:

Bldg. 4650, 20 yard roll-off bin, normally 30% cardboard, emptied 6.5 times per month,

Bldg. 4619, 20 yard roll-off bin, 80% cardboard, emptied 3.5 times per month,

In addition, the following list is of those bins, from the visual inspection, containing 30% cardboard or more and at least 30% full at the time of inspection:

<u>Bldg. No.</u>	<u>Bin Location</u>	<u>Size (cu yds)</u>	<u>Collection (days/wk)</u>
4200	north	2	5
4251	west	4	2
4471	north	8	5
4476	south	4	1
4482	south	8	1
4483	south	8	2
4487	west	6	5
4487	northeast	4	5
4492	east	6	1
4531	northwest	2	1
4539	northwest	2	1
4583	south	6	1
4596	northeast	2	1
4650	north	4	3
4650	west	6	3
4653	southwest	6	2
4655	north	4	2
4667	south	2	1
4671	south	4	5
4678	south	2	1
4707	east	4	2
4712	north	8	5
4727	north	4	3
4728	south	8	3
4752	south	4	2
4755	west	8	5
8023	north	8	1
HPD	east	6	2*

\*during scheduled practice

Since the above is based on only one visual inspection, before any action is taken, the percent of cardboard present in each of the bins should be subjected to confirmation; i.e., more inspections.

3. A concerted effort should be made to capture more of the white paper at certain office buildings which the study revealed as ending up in the regular refuse. Especially in evidence (during both the manual and visual sorts) was Building 4203. The following buildings in the visual sort indicated an excess of mixed paper; i. e., 30 percent or more of office paper with the bin 30 percent full or more at the time of the visual inspection. Mixed office paper would include paper not suitable for the white recycle bins. (It was not possible to visually determine percentages of different grades of paper.) Because of this, these buildings should be further monitored for excessive white paper before action is taken.

<u>Bldg. No.</u>	<u>Bin Location</u>	<u>Size (cu yds)</u>	<u>Collection (days/wk)</u>
4241	south	6	2
4249	east	6	5
4250	west	8	4
4312	west	4	3
4313	east	6	1
4347	north	2	1
4485	southeast	4	3
4487	southeast	6	5
4491	northwest	4	5
4674	south	6	3
4817	south	6	2

4. More important than capturing more of the waste stream is ensuring that the recyclables have contamination levels within standards. Only one white paper BFI recycle bin appeared to be above the one percent maximum outthrows, containing a large amount of drafting vellum paper. One possible solution would be attaching large labels to the BFI bins stating what is not acceptable.
5. Consideration should be given to constructing a specially designed lid for the sawdust bin located on the south side of Building 4471, allowing the sawdust to be discharged into the bin as needed while hindering the disposal of food and drink waste, cardboard and wood. (Note: Attempts at educating employees at this building has not been successful. This contamination could be the result of drive-by drop-offs. Labeling the bin has been ineffectual. Refer to Photograph No. 2.) This sawdust should make good composting material. Emptying the bin at compost pile would be a problem to solve.

6. Likewise, the 20 yard roll-off bin located south of 4471 could be modified to accept flattened cardboard only to discourage contamination from drive-by drop-offs.
7. Many of the MDI refuse bins are in poor shape: dented or holes rusted through along the bottom. Refer to Photograph 1. In those containers that were nearly empty, most contained 6-8" of water, indicating that the drainage holes are plugged.
8. It was discovered that a significant percentage of the employees would like to do more recycling. An on-site drop-off center for employees, especially for those that do not have city curbside service, would facilitate this. The center could be centrally located, with drive-by bins. Not only will this increase the amount of recyclables, but encouraging employees to do more home recycling should carry over into the workplace.
9. Calls were made to two local firms [53, 54] that deal in surplus office computers, to determine if anything could be done to increase proceeds from Building 8025 auctions. (A tour of that facility indicated that the majority of excess equipment was outdated computers, terminals, and computer peripherals.)

Yesterday's Computers of Madison, AL, is not interested in buying computers that do not possess a 386 CPU chip. (Earlier generations are not salable. They have found no market for old mainframes or dumb terminals.) Resale would depend on the particular machine, but one should not expect to get more than 20 percent of the original cost. Old model computers that this company cannot resale to individuals are sold to a scrap dealer for 15 cents to 20 cents per pound. [53]

CompuWorks, located in Huntsville, reported that they receive a majority of their machines from the MSFC auctions. Between 45 - 60 percent are not salable due to rough handling. This rough handling is thought to be the result of moving the machines around as they are being excessed--not through normal use. (It takes 14-18 months for a piece of equipment to be excessed during which time it passes through numerous hands.) CompuWorks extracts the precious metals from these unsalable machines and then turns them over to a scrap dealer. This company had offered a proposal to the Boeing Company by which they would receive old computers, monitors, printers, etc. in exchange for a \$20-\$30 credit towards a new purchase. This should cut down on breakage, garner higher proceeds for these machines plus eliminate the costly expense (estimated at \$300 per item) of the excess process. (As before, this company is not interested in all old computers--no mainframes, dumb terminals, or Unisys machines.) [54]

In order to consider this suggestion and others, MSFC would need to initiate some form of recordkeeping to keep a listing of the type, age, condition, and quantities of equipment it processes for excess. No such records, other than auction proceeds, are not kept. [15]



10. Investigate the potential to have restroom paper towels sold or given to a third party for composting. Install electric hand dryers in office buildings, as possible and affordable.
11. As an alternative to suggestion 10, install cloth roll-type towels for drying hands in place of the existing throw away paper towels. Note: Employees may object to this. A poll may indicate if employees would be receptive to this idea. As an alternative, restrooms could be augmented with cloth towels and their use encouraged.
12. Give each employee his or her own coffee mug. Styrofoam coffee cups could be eliminated or their use discouraged.
13. Encourage all housekeeping employees to do limited sorting, as needed, of employee's trash and white paper receptacles, supplying them with needed equipment or extra bins.
14. Consider adding more aluminum can bins. Having one bin only located by the soft drink machines does not appear to be adequate; it is inconvenient enough to discourage some employees from recycling their cans. (Refer to Suggestion 21, as an alternative.)
15. Consider setting up individual magazine containers in select buildings; such as the 4200 complex of offices, the computer facility of Building 4487, the Graphics Area of Building 4471, and Building 4250 (a sizable amount of magazines appeared in the manual sort of this building). Presently, there is a magazine bin in building 4708--the Boeing building. (Note: BFI does not presently pay for magazines. [20])

In conjunction with this, consider the use of separate stackable bins for central collection places in building hallways. The combination of bins can be adjusted depending on generation rates of each commodity making for a flexible system.

16. The following are specific employee suggestions as a result of the survey:
  - a. Place a phone book recycle bin on each floor instead of the first floor only (Bldg. 4666.).[115]
  - b. Add an aluminum can bin on the second floor of Building 4487. [124]
  - c. Check if there is a laser cartridge recycle bin in Building 4203, fifth floor. The employees here appear to be stacking the cartridges in the copy room. [127]
  - d. Verify that the graduate fellow in Building 4487, has her own white paper bin. [125]
  - e. During the survey, the aluminum can bin outside the lunch room of building 4708 was overflowing. Unless this was a unique situation, another bin needs to be added or the existing one replaced with one of more capacity. [130]

17. There are three 20 yard roll-off bins for foam at Building 4707. They are monitored and emptied when full by the MDI contractor--from one to four times per month resulting in approximately 2000 cubic yards/year requiring disposal at the RSA inert landfill. The raw ingredients for this foam (A and B components) are purchased and the cryogenic insulation foam (MCC-1) is blended on-site. [141] Although beyond the scope of this study, it is recommended that MSFC research the potential to minimize this item by reducing its volume by dissolving or melting the foam chemically or to research a possible recycle market..
18. The following are ideas concerning education of employees on recycling. Place articles in the Marshall Star, discussing general recycling information. For example include: recycling labels and what they mean, a list of products made from recycled products, the global and regional impact to not recycling, ideas of how employees can turn household "trash" into craft and other items. Discuss how employees can augment their home recycling efforts. (For example, Wal-Mart, Kroger, and Brunos now have bins for recycling plastic bags.) Explain how to dispose of old paint, where to take old lead batteries, tires, and used oil, how to dispose of unused household chemicals. ( Residents of Madison County can take paint, pesticides, batteries, auto fluids, and household chemicals to the Huntsville Incinerator from 8-12 noon on the first Saturday of every month and by appointment. If paint has been dried out, it can be placed with the regular household trash for pick-up. [93] ) Let employees know where they can take their commodities if they do not have curbside collection. (BFI located on Commercial Drive has outside bins for cans, newspaper, plastic, and brown and green glass. Refer to Photograph No. 14. They offer remuneration for aluminum cans only, however. [5]) List local firms that buy commodities, minimums that they accept take, and specifications that must be met. Include charitable organizations that collect commodities, such as Community and Family Services [17]. Inform employees that extra recycle bins can be purchased from BFI for \$1.00. [134]

Consider rotating posters. Rotating posters save money and keep interest up by varying messages. Consider such items as EPA530-K-92-003, The Consumer's Handbook for Reducing Solid Waste, as employee handouts. (Note: EPA's Office of Solid Waste has a National Solid Waste Information Clearinghouse consisting of a library, an electronic bulletin board, fax and hotline (800-67-swich) for obtaining information on recycling and source reduction among other solid waste topics.) [47]

19. Consider the option of handing over recycling operations to local charities. For example, the army, lets the Community and Family Service volunteers recycle their aluminum cans. These volunteers provide containers, which they empty and clean, the transport and sale of the cans in return for retaining the proceeds for their organization. [17] Many of these organizations may be willing to recycle a low volume commodity that BFI finds unprofitable. Any change that increases recyclables would be worth implementing even if MSFC sees no proceeds from it. Such action would extend landfill life, conserve raw materials, add to MSFC's image

as a "good citizen" of the community.

20. The company survey portion of the study revealed a number of commodities that are being recycled at other companies and have potential at MSFC. These include:

Photograph negatives [112, 113],  
Fluorescent lights [113],  
3 1/2" computer diskettes [113],  
Batteries [113],  
Toner cartridges from copy machines [113].

21. Consider supplying each employee with a compartmentalized recycle box. (Refer to [113].) Convenience is a major factor in participation rate.

#### Ideas Considered But Rejected

Ideally everything can be recycled or disposed of in an alternate manner to incinerating and landfilling. However, many items cannot be recycled at a profit, be it small, or even at no cost. [19] The following lists those ideas that were considered for MSFC, but were rejected as being too costly or impractical for implementation at this time.

1. Collecting mixed paper as opposed to white paper only. This would capture more of the waste stream--not only nonwhite paper, but also more of the white paper that ends up in the regular trash due to confusion of what is acceptable, or unwillingness of employees to take the time to tear off report covers and separate out notebook dividers. Under the present system no monetary gain would be realized from this as BFI does not pay for mixed paper, although they do accept it.

It should be noted, however, that the market for mixed paper is improving. A plant in Oregon, which opened in 1992, employing an advanced deinking process, accepts low grade mixed office paper which it turns into pulp for producing a relatively high grade copier and printing paper. Businesses that sell to this company can throw virtually all their paper into one container: white and colored paper, third class mail, magazines, catalogs, newsprint and corrugated cardboard, thus upping their recycling rates to a 70 to 80 percent, per the referenced article. This plant pays \$110/ton for the mixed office paper, compared to about \$150/ton for high grade paper. More plants are starting to invest in this new technology with the trend being to accept more types of paper. [37, 52]

Indeed, Boise Cascade is scheduled to begin construction of a paper recycling plant at its existing pulp and paper mill in Jackson, AL. When complete, the facility will convert approximately 320 tons per day of mixed waste paper into recycled business and writing papers. Feedstock will come from paper brokers and municipal and commercial recycling programs within a 500 mile radius. (MSFC is approximately

85 miles away.) New technology will allow the company to process waste paper, that was previously too dirty or otherwise couldn't be used, to make quality recycled fiber. [33]

Ithaca College in New York collects mixed paper: white and colored paper, junk mail, check stock, computer paper, copier paper envelopes with or without windows, file folders, magazines and textbooks. The paper is collected free by a paper mill in containers which it supplies. The mill then sells toilet tissue back to the college, offsetting this bill, by the paper collected. By accepting an expanded range of paper type, the school has quadrupled its original recycling volume. [38]

(Note: Paper contaminated with food waste, carbon paper, paper combined with plastic film, foil laminated paper, carbon paper, and brown paper sacks are still not acceptable.)

2. Substituting air dryers in restrooms to replace paper towels for hand drying was rejected. It was felt that this would meet with employees' objections as impacting productivity by taking too long or not getting hands sufficiently dry. However, a poll could be conducted to gauge employee acceptance.
3. An idea to replace fountain drinks with recyclable canned soft drinks was rejected. Fountain drinks are a nicety for the benefit of the employees and adds to worker well being.
4. Although one of the companies surveyed reported an extremely high participation rate as the result of mandatory recycling, the implementation of mandatory recycling was rejected. As stated during the employee survey, if an idea makes sense and will not impact productivity, the employees will accept it. All employees that were surveyed during the study were positive on recycling, albeit some more than others. All realized the need to recycle. Resistance came when it was viewed as too inconvenient.
5. Instituting individual building incentives was rejected. The idea here would be to reward those buildings or centers that recycle the most based on product used. Although it has been shown that cash awards have been a very effective method of stimulating participation [149], this idea is viewed as requiring too much manpower and specialized equipment to segregate and weigh recyclables and trash on an building-by-building or center basis.
6. Collection of newspaper as a separate commodity, for resale or composting (with the exception of including it in a drop-off center, or as a charitable, no cost program) was rejected. The visual and manual sorts did not indicate sufficient quantity of this item.

7. Allowing employees to take home cardboard boxes and plastic ware for their use was rejected. It is felt that the temptation for a few individuals to siphon off these commodities would render it too problematic.
8. It is not recommended that MSFC take over processing and sales of scrap metal, now being handled by DRMO. This option was evaluated since DRMO proceeds go to the U.S. Treasury rather than being returned to MSFC. Although not directly related to recycling, it was felt that if these proceeds went into MSFC coffers, they could be used to improve and expand their recycling program. Conversations with DRMO [21] revealed that such a facility would require approximately five acres minimum (the DRMO facility includes 16 acres) and \$500,000 to \$1,000,000 in capital investment. Expected selling prices per pound were obtained (with the exception of Al Li as records for these commodities were not available). For those six commodities where prices were available, commodities processed by DRMO for MSFC during a six month period (see Table 3.5.b), were generously computed to return \$18,000. (Most of the expected sale prices were in the form of a high and low. The high price was used.) DRMO makes a profit once processing costs are deducted, but this is mainly attributed to their high volume justifying the facility and full time employees.

However, of even more significance than the poor expected return on investment, is the present ruling on disposition of these commodities. Not only does scrap metal not qualify as a recyclable, but only when "metal" is procured with nonappropriated funds (not from tax revenues) can programs receive resale proceeds. Therefore, regardless of the method or agency used to dispose of the scrap metal, these receipts must be returned to the U. S. Treasury. [21] (Note: It is anticipated that this ruling will change. [7].)

(In conjunction with this is an article that appeared in The Huntsville Times. In 1988, Congress approved what would become a \$3.8 billion program for NASA's Solid Rocket Motor program. The program was canceled in 1993. NASA was able to offset the cost of terminating the program by selling as much of this equipment as possible rather than declaring it as excess. Per this article, property declared excess can be transferred to other government agencies. If it's sold then, the money goes back to the U.S. Treasury, not to NASA. The agency has hired a professional auction company and hopes to recoup 30-40% of \$98.5 million invested in equipment alone. During a two- day auction in MS, NASA made nearly \$2 million on the sale of plumbing, AC equipment, small tools, office furniture and other building supplies. In addition, the agency is taking offers on giant lathes, boring machines and other unique items. [Therefore, it appears possible--however unlikely-- to change current rulings concerning disposition of proceed sales.][29])

## Lessons Learned

As with any project, regardless of the level of preproject planning, not all goes as anticipated. This section discusses those portions of the study that did not proceed as originally planned, for a variety of reasons, and alternate activities that were then substituted.

It was planned to compute quantities of potentially new recyclables from data obtained from the visual sort, using data from the manual sort as a check. This was because each bin was visually inspected, as opposed to manually sorting six bins only; the visual inspections requiring less time and manpower. The volume for each commodity was computed taking bin size times pick-up schedule times percent full when emptied [9], times the percent volume that each commodity composed. This was done for each bin, then the individual bin volumes were added to get a total volume for each commodity. Literature publishes commodity densities [18]. However, it was decided that a more accurate density could be obtained by weighing the commodities. This was done during the manual sort. (For example, published numbers indicate that one cubic yard of fine paper or newspaper would weigh 500 pounds. The manual sort indicated that, as collected, office paper or newspaper, on average weighed 180 pounds per cubic yard. Unflattened boxes were weighed and found to be about 8 pounds per cubic yard.) However, potentially new recyclables computed in this manner resulted in an unrealistically high number. The yearly volume of solid waste was computed from this same listing. From this, an overall density of 51 pounds/ cubic yard was computed using "truck" receipts (Table 3.6). Similarly, a density of 67 pounds per cubic yard was computed for the six manually sorted bins. These two numbers, which are in statistical agreement, indicate that the densities used for the individual components are suspect. Note: A weight/volume for each of the bins was computed as follows:

BIN	DENSITY
Bldg. 4203	98 pounds/ cubic yard
Bldg. 4250	90 pounds/ cubic yard
Bldg. 4471	44 pounds/cubic yard
Bldg. 4666	46 pounds/cubic yard
Bldg. 4705	62 pounds/cubic yard
Bldg. 4708	40 pounds/cubic yard

It was also planned to perform the visual inspections before their scheduled pick-up. It was thought this would not only reveal percent volume of each component, but also percent full when emptied. However, it was later learned that pick-ups for the MSFC buildings start much earlier than thought--around 2 a.m. Therefore, the MDI contractor was contacted for this information (very probably resulting in more accurate data than would have been gleaned from the original plan). It was also discovered that a better estimate of the volume composition of the bins could be made when the bins are around 30 percent full, as opposed

to being close to empty or to full. Therefore, a better plan would have been to inspect the bins disregarding the pick-up schedule. This would have also reduced the time spent performing this task by about 50 percent as the site was transversed numerous times and numerous trips were made to try to schedule the inspections prior to each bin's pick-up schedule. Also a different method of inspection may have revealed the presence of buildings that contained bins that were not on the MSFC listing

It was suggested that a comparison be made of the visual and manual sorts to gage accuracy. This was done (See Section 3.) However, this exercise has limited value as there was no way to make a volume to weight conversion. The suggestion was made after the manual sort was completed. At the time the manual sort was done, the overall volume of each bin was noted, but not the percent volume of each commodity. Comparing these volumes to the actuals would have provided a check (albeit a questionable one) of the accuracy of the visual sorts. This would also have provided another method (again questionable) of computing commodity densities.

Some information was not released for use or not received as expected: MSFC receipts from recyclables processed at BFI, records from ISS (now City Environmental Services) on MSFC tonnage sent to the Huntsville landfill prior to January 1995, a record of proceeds from surplus equipment sales. Substitute data was used, which although not as accurate as that requested, was considered adequate for the report.

## **Section 7**

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**Appendix A**  
**Employee Survey**

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/22/94

**Building Number:** 4203 - Second Floor

**Employee Job Title:** Configuration Management Engineer -- Pace and Waite [116]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes. I have not changed out the laser cartridge in my printer but would recycle it. This recycle box is in the copy room.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes. The paper basket is small but adequate. However, the instructions have been placed on the inside bottom and are partially torn away.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? I would call the number listed in the phone book under Recycling.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes for the phone books. Wouldn't know about picnics.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, I'm aware of all that pertains to me.
8. Do you have any suggestions for how we can improve the program? No.

(Author's Note: Two aluminum can bins are located by the pop machines and a telephone bin was situated by the elevator, ~ 80% full.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/22/94

**Building Number:** 4203 - Third Floor

**Employee Job Title:** Program Analyst. [134]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes. I take my aluminum cans that I buy here home. We sell our cans to Hinds Salvage. This pays for three months of trash collection at our house.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? No, this is my own opinion. I feel that I am well informed of what to recycle.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, I'm familiar with the restrictions that apply to me. I use white post-its.
8. Do you have any suggestions for how we can improve the program? No.

(Author's Note: This employee is very positive on recycling. She bought an extra recycle bin from BFI for \$1.00. She suggested that the company eliminate excess pages between printing jobs and to put bins by each printer. Both suggestions were implemented. She takes her excess plastic bags to Kroger. She also called around trying to find a buyer for hard plastic food trays but was unsuccessful. )

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/22/94

**Building Number:** 4203 - Fifth Floor

**Employee Job Title:** Student Aide - part time in winter, full time in summer. [127]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes. I have a white paper bin and feel the bin for the cans is convenient. However, I'm not aware if there is a separate bin for the laser cartridges. I put mine in the copy room.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? Possibly cardboard.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? Yes.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I was aware of restrictions on the yellow post-its and notebook dividers, but I've been removing the staples from my white paper.. I would like to know where to take my laser cartridges.
8. Do you have any suggestions for how we can improve the program? Refer to Nos. 6 and 7 above.

(Author's Note: There were four used cartridges in the copy room but no bin. There was a telephone recycle bin located by the elevators. It was overflowing or ~ 140% full.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/29/94

**Building Number:** 4708

**Employee Job Title:** Mechanical Engineer. [128]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes. I have a white paper bin. The bin for the cans is located by the machines. For us, the Safety Monitor handles the laser cartridges.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I am aware that I can leave on staples and paper clips, and I know no yellow post-its. I was not aware that white post-its are available. I was told that blue line cannot go into the white paper bin if it contains too much blue. I was also told that I could not put white paper in the bin if it contains too much colored print. Therefore, I would say there is a need for education. However, I am not interested in attending a meeting or film on this--no time. I would suggest putting up posters.
8. Do you have any suggestions for how we can improve the program? Refer to No. 7 above.

(Author's Note: A can bin and telephone book recycle boxes were located by the double doors for this floor.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/29/94

**Building Number:** 4708

**Employee Job Title:** Secretary - DLA [129]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes. I have a white paper bin. The bin for the cans is located in the hallway. I've only been here a couple of months and was not aware that the laser cartridges were recycled.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? I would talk to the housekeeper who picks up the white paper.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) No need for education. I'm aware of the restrictions that apply to me.
8. Do you have any suggestions for how we can improve the program? No.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/22/94

**Building Number:** 4708

**Employee Job Title:** Welder - Boeing. [130]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Most of our white paper is track feed. I deal mainly in blue prints. We don't dispose of any of these--they are returned to Engineering.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? The aluminum can bin is located right outside the lunch room. However, it is presently overflowing. (This is unusual and could be because of the time of year).
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No. We deal almost exclusively with aluminum which we are currently recycling. All our aluminum goes into the recycle bins unless it can be used here.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Cannot say.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin? ) No need for education. The maintenance crew provides us with instructions.
8. Do you have any suggestions for how we can improve the program? Refer to No. 2 above. A can crusher would not be a good solution. We only have 10 minutes for our break--wouldn't have time for this.



## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/29/94

**Building Number:** 4483

**Employee Job Title:** Transportation Assistant. [131]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to the white paper and cans. I don't have a laser printer.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The can bin is located by the coke machines, which is adequate. I collect cans at my desk for a couple of days and then carry them to the bin.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? Possibly newspaper. Possibly our own recycle bin for cardboard--the crews buy cases for oil that come in cardboard boxes. Also many parts come in cardboard boxes.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes for phone books. The soft drinks are served in plastic cups at company picnics.
6. Is there a need for more promotions and advertisement? Yes. I am aware of some of the employees in my department putting white paper in the regular trash. It appears to me that if there is a question, our employees will put potential recyclables in the regular trash.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) (See above.) I was not aware that staples could be left on--I remove them. I am aware there are white post-its but prefer the smaller yellow ones. I know not to put them in the recycle bin. I live in Limestone County which does not have a recycling program. I would like to do more, but am unsure how. People need to be educated on the impact to us, our environment, and our children's future if we don't recycle now.
8. Do you have any suggestions for how we can improve the program? Refer to No. 7 above. Also, if you weren't so fussy about what can and cannot go in the white paper bin, more would be recycled.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date: 12/29/94**

**Building Number: 4666**

**Employee Job Title: Computer Programmer. [132]**

- 1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.**
- 2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? I have a white paper bin. The bin for the cans is not convenient. I don't always recycle them because of this. It would be more convenient to have one in each hallway or near office doors.**
- 3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.**
- 4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.**
- 5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes for phone books. Have not noticed concerning company picnics.**
- 6. Is there a need for more promotions and advertisement? No.**
- 7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, I believe there is a need to educate new employees and a need to inform people who to contact, if needed. I did not know that staples and paper clips could be left on white paper. I knew yellow post-its and dividers were not to go in the bin. I was not aware that there are white post-its available for use.**
- 8. Do you have any suggestions for how we can improve the program? Refer to Nos. 2 and 7 above.**

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/29/94

**Building Number:** 4666

**Employee Job Title:** Aeronautical Engineer. [133]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to white paper and cans. The Computer Service Group handles changing our laser cartridges.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. I very seldom buy soft drinks.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? I would ask the secretary.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? No, most people are aware of the program.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) No need for education. I know about staples and paper clips and not to place yellow post-its in white paper bin.
8. Do you have any suggestions for how we can improve the program? No, I believe the program is doing fine.

(Author's Note: The laser cartridge bin for this building is downstairs in the hallway.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/29/94

**Building Number:** 4666

**Employee Job Title:** Secretary. [115]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The bins for the cans and cartridges (downstairs) are adequately located.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes to both. The bin for recycling the phone books is located downstairs.
6. Is there a need for more promotions and advertisement? Not really. Everyone seems to be participating. People are aware of recycling because most are doing it at their homes.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I know what to put and not put in the white paper recycle bin. I have white post-its to use and do not put yellow ones in the bin.
8. Do you have any suggestions for how we can improve the program? It would be better to have a phone recycle bin on each floor instead of on the first floor only.

(Author's Note: The laser cartridge bin for this building is downstairs in the hallway.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4650

**Employee Job Title:** Engineer - Teledyne Brown. [117]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to the white paper. I very seldom drink soft drinks but would throw the can in the recycle bin by the coke machine if I did. I use a dot matrix printer.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No, but I believe it would be fairly easy to find out if I needed to.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? Some magazines and some newspapers.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes to both. The aluminum cans are collected at the picnics.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I leave in my staples but did not really know if this was okay. I do not deal with blue line and have very little vellum. I did not know it was not to go in the white paper bin. I know yellow post-its are not to go in the bin. Did not know there are white post-its.
8. Do you have any suggestions for how we can improve the program? No.

(Author's Note: A phone recycle box was located in the hall.)

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4663

**Employee Job Title:** Technical Lead - INET. [118]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The bins for the cans and cartridges are adequate--their locations do not prevent me from recycling.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? Yes, Brenda Wade, our NASA contract contact.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes to the phone books, there is a recycle box in the hall. I was surprised at a picnic I attended that there was not a separate bin for the aluminum cans.
6. Is there a need for more promotions and advertisement? Yes, there is a need for posters.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I leave in my staples but did not really know if this was okay. I know not to leave on yellow post-its and not place dividers in the bin. Was not aware that there are white post-its available.
8. Do you have any suggestions for how we can improve the program? Some of the bins could be more conveniently located. You need to recycle cans at special events. There is a need for information on home recycling, especially for those employees that live outside the city and do not have curbside recycling. For example, I need to know what to do with my excess paint. Right now I'm collecting it in my garage.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4471

**Employee Job Title:** Appendix D Property and Supply Supervisor - MSI Member of the Recycling Committee. [119]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes to all. I have a white paper bin. The bin for the cans is located by the coke machines. I do not mind walking that far to deposit my cans. My group is responsible for recycling the laser cartridges.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? Yes, but I don't feel there are problems with the program. BFI is very responsive when we call them to pick-up a roll-off bin.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? I would like to see everything recycled.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? Yes.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, I'm aware of the above, but we need to educate people on what to put into the bins and what not to. In walking through the building, I see colored paper in the white paper bins and white paper in the regular trash. Sometimes we have to separate the cardboard and wood in the dumpster itself. I believe that drive-by's contaminate our bins. Also, I see corrugated in the regular trash due, I believe, to careless employees. We need to let people know the return that Marshall gets from their recycling efforts.
8. Do you have any suggestions for how we can improve the program? A bin for magazines would probably do well in this building. We need a collection for mixed paper. Too many rules about what to put in the bin and what not to discourages recycling. I would like to see our own recycle center at the Arsenal. Check into incentives. It doesn't have to be

**much: an in-house party or certificate for that group that does the best. Each center needs to reap the benefits of their recycling as opposed to these moneys going into a general fund. My department is responsible for recycling of the laser printers. We do not get back what we buy. We constantly need to purchase 30% to make up the shortfall.**



## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4471

**Employee Job Title:** Graphics Technician. [120]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? I participate in recycling white paper, but not cans. I don't buy many soft drinks, but I probably would not take the time to walk down and deposit the cans in the bin. I do not change out laser cartridges.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The bin for the cans is not convenient.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? I would talk to my supervisor.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? Magazines--we receive a lot of computer magazines in my group.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes to the phone books-- there is a phone recycle bin by the coke machines.
6. Is there a need for more promotions and advertisement? Yes, more should be written about the program and recycling in the Marshall Star
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Was not aware that staples could be left on. I was aware of the restrictions against yellow post-its and notebook dividers. I was not aware that there are white post-its.
8. Do you have any suggestions for how we can improve the program? Refer to Nos. 2 and 6 above.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4471

**Employee Job Title:** Administrative Assistant II. [121]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The bin for the cartridges is down the hall. We save our own cans here in the office--one of our office personnel collects them in a box. I don't know what she does with them, however.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? Shirley Wright.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I was not aware that staples could be left on. I was aware of the restrictions against yellow post-its and notebook dividers. I also know that white post-its are available.
8. Do you have any suggestions for how we can improve the program? No

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4410

**Employee Job Title:** Training Manager for NASA. [122]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to the white paper and cans. I do not use a laser printer.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. The bin for the cartridges is in the hallway, so it's convenient enough for me.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes to the phone books. The aluminum cans are collected separately at company picnics.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I was aware that staples could be left on and not to put yellow post-its and notebook dividers in the recycle bin. I did not know that white post-its are available.
8. Do you have any suggestions for how we can improve the program? We also need to concentrate on waste minimization.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4487 - Second Floor

**Employee Job Title:** Engineer. [123]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to the white paper and cans. I have never changed out the laser cartridge on my printer.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. I generate very few aluminum cans. I put these in the white paper bin also.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No, but I don't believe it would be too hard to find out.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No, I deal almost exclusively with white paper.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes, to the phone books. I haven't been to a company picnic in a while.
6. Is there a need for more promotions and advertisement? No, not unless there is a change in the program.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, I am aware of those items that apply to me. However, I was not aware of there being white post-its.
8. Do you have any suggestions for how we can improve the program? No, but if there are other items that can be recycled, then they should be. Don't, however, get too authoritarian. If it's easy and makes sense, people will participate. Don't yell at people if they screw up--we have other priorities.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4487 - Second Floor

**Employee Job Title:** Computer Engineer. [124]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to the white paper and cans. Someone else is in charge of changing out the cartridges
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper bin. I usually stack my pop cans at my desk. There is only one bin located downstairs. There needs to be an aluminum can bin on the second floor also.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? We receive computer sale magazines and deal in colored paper. One or two bins in the hallway for magazines and colored paper might work here.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes, to the phone books. I don't go to the picnics.
6. Is there a need for more promotions and advertisement? For some things.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes to the staplers but only because I asked. I knew not to put yellow post-its or heavy paper in the white paper bin.
8. Do you have any suggestions for how we can improve the program? Refer to Nos. 2 and 4 above.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4487 - First Floor

**Employee Job Title:** Fellow in the Graduate Program. (Employed at the Arsenal since August.)  
[125]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? I recycle my white paper. I do not have a printer.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? I do not have a white paper trash bin at my desk. I haven't been able to ask the custodian for one since I'm not at work when the paper is collected.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? No.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? Not at work.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes, the phone bin is in the hall. Cannot say about company picnics.
6. Is there a need for more promotions and advertisement? See answer below.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) Yes, there is a need for education as I was not aware that each employee should have a white paper recycle bin at his or her desk.
8. Do you have any suggestions for how we can improve the program? Refer to No. 7 above. Also, I believe you need to educate people on what can happen if people don't recycle.

## **MSFC RECYCLING PROGRAM**

### **EMPLOYEE SURVEY**

**Date:** 12/30/94

**Building Number:** 4663

**Employee Job Title:** POCC Administrator - New Technology. [126]

1. Do you participate in NASA's recycling program; i. e., do you place your white paper, aluminum cans, and laser cartridges in the proper bins? Yes to all.
2. Do you have what you need to participate; i. e., a bin for your white paper, convenient bins for cans and cartridges? Yes, I have a white paper receptacle. The bin for the cans is located in the central hallway.
3. Do you know who to contact if there is a problem or if you have questions or suggestions for improvement? Yes, Brenda Wade, the NASA Administrator.
4. Are you aware of having an abundance of potentially recyclable materials that are not being collected for recycling? No, I feel we are doing all we can. We keep any excess cardboard boxes as our employees use them for travel and to send reports, etc. to Washington. We have some magazines and colored paper, but not enough to fool with. We have paper bins by the fax machines. A lot of paper is generated during SIMS but everyone here appears to be recycling it. We also reuse our manila folders.
5. Do you get proper service for seasonal items, such as for telephone books and at picnics? Yes for the phone books. Can't comment concerning company picnics.
6. Is there a need for more promotions and advertisement? No.
7. Is there a need for education? (Examples: Did you know that blue line is white paper but vellum is not, that staples and paper clips can be left, but not alligator clips, that yellow post-its and notebook dividers should not go in your white paper bin?) I am aware of the rules that apply to me so I don't believe there is a need for education.
8. Do you have any suggestions for how we can improve the program? No.

**Appendix B**  
**Company Survey**



## RECYCLING PROGRAMS

### COMPANY SURVEY

Company: Fort Rucker

Date: 01/17/95

Contact: John Clancy (334-255-9505) [95]

The recycling program under the direction of John Clancy at Fort Rucker presently recycles the following items:

- PET plastic
- HDPE plastic
- tin cans
- aluminum cans
- corrugated cardboard
- glass
- newspapers
- computer paper
- white ledger paper
- steel cans

Fort Rucker has a Recycling Center with thirteen employees. Although Mr. Clancy is unsure of the total amount of recyclables that they process, there are over 1500 residences, plus offices and other buildings at the site. The residences have curbside service of recyclables. The contractor who collects the recyclables, separates the cans and plastics, but not the glass. Glass separation (by color) is done at the center and requires one full time individual. The center also includes drop-off bins. Newspapers are collected in this manner. Cardboard boxes, plastic containers and steel cans are collected at the mess halls. The city surrounding Fort Rucker does not presently have a curbside recycling program. They do, however, have drop-off bins for the residents. Fort Rucker picks up and processes these recyclables along with the base's. The center has one baler that is used to bale paper, plastic, and cardboard. It operates continuously with one bale produced every 35-40 minutes. (Paper bales are 2000 pounds.) The center would like to buy a new baler capable of outputting a bale every 3-4 minutes as the present system can barely keep up with the supply. The center also has its own tractor, trailer and truck dock for pick-up and delivery to buyers/dealers. Fort Rucker solicits requests for bids monthly for each commodity and sells to the highest bidder. Presently they sell their corrugated and paper to Alabama Fiber of Mobile, their glass to GDS and their plastic to K&W of Troy, Alabama. They feel that they get the best price for their product by collecting and baling themselves, in addition to paying for their labor and equipment. The recycling program at the fort is voluntary. Per Mr. Clancy, only about 30% of the offices and 50 -55% of the residences actually recycle. The center will provide anything, within reason to facilitate their recycling efforts, but the employees must request it (bins, containers, etc.) An aluminum can bin can be provided for each office, if so desired. Mr. Clancy would like to see incentives incorporated to boost participation, but, so far, this has not been done. There is a major problem at the base with commingling and contamination in spite of labelling of bins and boxes. The base landfills its solid waste at \$20/ton.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company: Boeing Aerospace; Huntsville, AL [96]**

**Date: 01/04/95**

**Contact: (Would prefer not to give.)**

Boeing Aerospace currently has approximately 2000 individuals in its employ. Presently the company recycles white ledger paper, aluminum cans, and magazines. Each employee has a white paper recycle box at his/her desk. Aluminum can bins are located in the break areas. It is estimated that 90% of the employees recycle their white paper. Less recycle cans due to the relative inconvenience of these bins. Boeing has a contract with BFI for their recycling program. The program is voluntary. The company is involved in recycling to be good citizens and not for monetary gain.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company:** Intergraph Corporation; Huntsville, AL

**Date:** 01/04/95

**Contact:** Mr. Harlow Fikes [97]

**The Intergraph Corporation presently recycles the following items:**

- office paper (white paper and envelopes)
- printer's mix (glossy paper)
- corrugated cardboard
- aluminum cans
- laser cartridges
- scrap metal
- plastic reels used in printed circuit boards

Each employee has a folder at his/her desk for excess white paper. It is believed that there is over 80% participation in recycling paper. The recycling program at the company is voluntary. One reason given for the high involvement is the relatively young age (average age: 34) of the employees. The paper, cardboard, and cans are sold to a local buyer. The laser cartridges are handled by a company in Huntsville. A call is placed for pick-up with each full palate of cartridges with the proceeds going to charity. Scrap metal from the machine shop and from construction activities are sold to a vendor in Decatur. The company does not recycle leaves/grass, magazines, or cafeteria waste. They investigated the possibility of recycling Styrofoam, but rejected it. (Note: There is a chemical that can be poured on the Styrofoam to shrink it.) The company does, however, purchase CFC-free foam. The company does not make money on its recycling program, per say, due to extra labor involved. However, they do feel that they save in reduced landfill and incinerator tipping fees and fewer garbage hauls. Most of the company's solid waste is sent to the incinerator.

## RECYCLING PROGRAMS

### COMPANY SURVEY

Company: Coca Cola Bottling Co.; Huntsville, AL

Date: 01/04/95

Contact: John Wilkinson (533-9450) [98]

The local Coca Cola Bottling company has a very aggressive recycling program. It is estimated by Mr. Wilkinson that 95% of their waste is recycled. (The company is classified as residential not commercial based on this.) The following items are recycled:

- white paper
- aluminum cans
- cardboard
- plastic bottles
- glass
- truck oil and freon
- high compact (plastic rings)
- shrink wrap

For November 1994, 23,320 pounds of aluminum and 39,000 pounds of cardboard were recycled. Their recycling program is mandatory: each employee is required to participate as part of his/her job requirement as specified in the Employee Handbook. Job stations are inspection to ensure compliance. However, there seems to be little resistance. It does not appear to impose a large burden on the employees. Only the break room has special containers. Each group sets up its own program as it desires.

White paper only is utilized at the facility. There are no post-its nor colored paper generated at the plant. There are no magazines to speak of. The company does not rake its leaves or grass. They do not feel this impacts the aesthetics of their facility. (The company has an in perpetuity beautification award given by the city.) However, any excess trimmings are taken to the Huntsville Botanical Gardens.

All their recyclables, with the exception of the high compaction and shrink wrap, are handled through BFI. BFI sat down with them and helped them set up their program when it was getting started. BFI empties and crushes their aluminum cans; rejects are deposited full or half-full in the bins. In addition, the company has a modified MRF located at their dock where they do a final sort to ensure no contamination of commingling and have a cardboard compactor and tilt top for white paper.

Mr. Wilkinson believes that BFI is the way to go for smaller operations. The markets are too volatile and labor too intensive otherwise--it is not cost effective unless you're in this business. Disney World attempted it and failed. No they use a private contractor. (Note: One advice given to them: switch from plastic cups to recyclable aluminum cans for serving soft drinks.) It's also better not to be too concerned about making money. Coca Cola receives revenue for their aluminum

cans and cardboard only. (Note: They are doing well with their program due to the high price--59 cents per pound--that they are presently getting for aluminum.) He also believes you need commitment from upper management. Per our discussion, Mr. Wilkinson does not feel it's feasible to recycle restroom towels: too high a potential health risk and no end user.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company: Maxwell AFB and Gunter AFB**

**Date: 01/17/95**

**Contact: Chris Christenson (334-953-5691) [99]**

**Mr. Christenson oversees the recycling centers for both Maxwell and Gunter Air Force Bases. The bases recycle the following items (although not all under Mr. Christenson's purview):**

- **mixed office paper including magazines**
- **colored ledger**
- **computer paper**
- **aluminum cans**
- **corrugated cardboard**
- **newspaper**
- **three colors of glass**
- **PET and HDPE plastic**
- **tin cans**
- **yard waste**
- **laser cartridges**
- **phone books**
- **tires**
- **used automotive oil**
- **bones and fat for the mess halls**
- **scrap metal**

**Presently the centers are manned by (free) inmate labor. The inmates have a week trial period. Normally, if acceptable, they remain at the facilities 6 months to one year. However, the centers are soon to be torn down and the recycling program is going to be contracted out. Mr. Christenson believes this is to make the program easier to fund. The program is voluntary. There are approximately 3500 employees at Maxwell, 2500 at Gunter. The estimated resident participation is 50 - 60%. The employee participation is estimated at 70 - 80%. These facilities are academically oriented with 25 - 30 schools at Maxwell and about 15 schools at Gunter. Mr. Christenson believes this contributes to the high participation rate. The biggest problem is in educating new employees/housing occupants. Also, the amount of recyclables that are processed lead to a hectic schedule. The centers operate Monday - Friday. If more than three days of processing are missed, large back-ups occur. There is not a problem with commingling or contamination. The bases are also trying to "procure smarter"; i.e., no colored paper. They use to separate out and sell their white paper as a separate commodity, but found it to be too labor intensive. Sixty to seventy tons of paper are recycled per month. Maxwell has a new compost facility, outdoor, with three windrows. The base is composting their yard waste, crushed pallets, and manure from the riding stable. Laser cartridges are shipped to New Hampshire. The base received \$3,000 last year from this program. Some cartridges slip through the system when the employees send them back in the box supplied by the manufacturer. The recyclables are sold to the highest bidder. Presently there**

are nine contracts. They run for various lengths of time. The base transports the plastics to the buyer. All other commodities (under Mr. Christenson's oversight) get picked up. The operating cost of the facilities is approximately \$150,000. The bases reap an avoidance cost (in reduced refuse fees) of \$30,000 - \$50,000. Due to the tripling of cardboard prices in the last three months, the program will only now start to show a profit. There is one incinerator for hospital waste, all other refuse not recycled is landfilled.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company: Teledyne Brown; Huntsville, AL**

**Date: 01/17/95**

**Contact: Ed Breland (726-1000) [100]**

**The recycling program at Teledyne Brown involves the following items:**

- **white ledger paper**
- **computer paper (both white and green bar)**
- **mixed paper**
- **aluminum cans**
- **corrugated cardboard**
- **phone books**
- **scrap metal**

**Presently there are approximately 2000 employees at the company (down from 4000 a few years ago). Every employee has a blue (paper) recycle bin. The company recycles about 500,000 pounds of paper per year. The company has an in-house recycle center. Each employee has a two can system: one for regular trash, the second for paper. Every night the janitorial staff takes the collected paper to a staging point (usually a building entrance). (The janitors can sort, but are under no contractual obligation to do so. They have, however, been instructed to pick out any paper soiled with food stuffs.) The paper is then picked up the next morning. Two individuals spend a portion of that day sorting the paper. The company receives a flat rate from BFI, higher than their normal contract because of the high quality (little or no contamination) of the product resulting in BFI usually being able to send the material straight to a mill. In addition, BFI uses the Teledyne Brown Center to train their (BFI) new employees on sorting. Grass and leaves are stockpiled and used as mulch around shrubs and trees. It is decayed but not composted matter. When a load of cans is ready, the company calls around to local buyers for the best current price. Proceeds from the sale of aluminum cans is funneled into a charity fund. The proceeds from the recycled phone books (5,000 recently) go to two elementary schools, which the company sponsors. BFI credits the company's dumpster charges from the proceeds received from their recycled paper. Although no money is received from mixed paper, the company goes to the expense of collecting and sorting it. Savings to Teledyne Brown comes from cost avoidance. They have been able to return ~ 60% of their dumpsters for a savings of about \$35,000 per year. They concentrate on roll-offs, with a \$500 per load dump fee. Those pallets that can not be reused, are broken down to save dumpster space. Excess furniture is also broken down to retrieve all metal that can be sold as scrap. (Scrap metal is sold to Miller & Son locally.) The company investigated cafeteria**



waste, but could not find any recycling potential here. They explored the possibility of recycling Styrofoam, but found it would be too expensive. (Note: It is Mr. Breland's understanding that Intergraph eliminated the problem of Styrofoam cups by providing each employee with his/her own coffee mug.)

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company:** ADS Environmental Services; Huntsville, AL

**Date:** 02/23/95

**Contact:** Toni Fortson (430-3366) [111]

**The recycling program at ADS Environmental Services involves the following items:**

- white ledger paper
- aluminum cans
- laser printer cartridges
- corrugated cardboard
- phone books
- solder
- magazines, both slick and newspaper type

The company here in Huntsville employees 125 people. (ADS has offices throughout the U.S.) The company has a recycle committee plus two subcommittees (for awareness and manufacturing). The company has an environmental policy which is contained in the employee handbook and is also posted in the building. The company president stands behind and promotes the program. The building contains what are called "recycle centers." Each employee is responsible for depositing his/her own paper and cans into one of two 90 gallon containers in the centers. These commodities are recycled through BFI which charges ADS a small fee. ADS does not receive any proceeds from these items. The company recycles their laser printer cartridges. Recharged cartridges cost them \$39.00 versus \$75.00 for a new one. There is one 55 cubic yard bin for cardboard boxes. This commodity is picked-up by ISS. Each employee is responsible for breaking down his boxes and placing outside his office for the cleaning crew to put in the recycle container. ADS does not receive proceeds for this commodity. The company recycles its solder by selling to a local scrap metal dealer. One of the employees, personally, takes the solder to the dealer, earning about \$500/quarter. The vendor that supplies the company with cable, takes back the smaller spools. Once per year, the company conducts a silent auction in which employees can bid on surplus computers. Those left over are sent to local vocational schools. ADS has implemented a number of actions to minimize their waste. They have ceased purchasing individual packets of sugar, etc. and now use canisters. This has reduced waste and is less costly. The coffee machine utilizes paper cups, but the employees are encouraged to use their own mugs. They've asked the employees to produce double-sided copies. The company ships a lot of product. They have switched from Styrofoam to foam-in-place for packing. This has resulted in a savings of \$35,000. The company uses fax post-its, eliminating the full first page that accompanies each fax. ADS is presently looking into

recycling their electronic scrap. They have discovered that one vendor sells items such as these to Third World Countries for processing; such as extraction of precious metals. Also Ms. Fortson referred to a company in Bynum, AL, Haynes of Haynes, reputed to be a "complete" waste recycling operation for possible recycling of "unique" items.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company:** The Huntsville Times; Huntsville, AL

**Date:** 02/17/95

**Contact:** Jim Stoltz (532-4000) [112]

**The recycling program at The Huntsville Times involves the following items:**

- white newsprint (no ink)
- printed newsprint
- brown wrapper
- corrugated cardboard
- Al/Mg plates
- negatives

The Huntsville Times sells its white newsprint, brown wrapper and corrugated cardboard to Huntsville Recycled Fiber. Printed newsprint is sold to a company in Florence, AL that uses it to make cellulose insulation. The Al/Mg plates are sold as scrap to a company located in MO. The camera department at the Times, processes negatives at the facility to recapture the silver. The negatives must be fairly recent to do this. The company does not have a separate program to recycle the aluminum cans. However, a number of employees do this on their own.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company: TVA; Knoxville, TN**

**Date: 02/17/95**

**Contact: John Homa (615-632-3564) [113]**

**The recycling program at the Knoxville TVA office involves the following items:**

- **white paper**
- **fluorescent lights**
- **aluminum cans**
- **magazines, books, newspaper**
- **HDPE and PET plastic**
- **corrugated cardboard**
- **phone books**
- **laser printer cartridges and toner copy cartridges**
- **3 1/2" computer diskettes**
- **negatives**
- **batteries: D cell and pager**

**TVA employs about 6,000 people. In addition to the Knoxville office, there are offices in two other cities. The Knoxville facility consists of two buildings, twelve floors each. Each employee has a three-part rebox container, about the size of a trash can. Normally, one compartment is for "wet" items, the second for white paper, and the third for aluminum cans. But each employee can decide what items to recycle. For example, an employee can collect glass or plastic, if so desired. In addition, each employee has a single compartment rebox that he can use for recycling or storage. Each employee is responsible for taking his/her trash to a "recycle center." There is one such center per floor. This is done about once or twice per week. (Note: TVA does not receive proceeds from recyclables. Most are given to "handicapped" organizations who will often collect the items themselves. But what TVA has been able to accomplish is the elimination of custodial jobs. Thus saving money in this fashion. Plus the company, by the nature of its business, is interested in conserving energy through the use of recyclables.) A vendor from Canada picks-up the batteries. This company pulverizes them, puts the batteries into a furnace to reclaim the metals. TVA has noticed that they are also receiving a significant number of batteries from homes. When the fluorescent lights first start to dim, they are given to the Partners in Education program for use in area schools. Those that are completely spent, but whole, are given to a vendor to recycle. Broken lights are sent to the TVA Muscle Shoals office to dispose of. Mr. Homa is not sure what Muscle Shoals does with them. TVA has eliminated restroom paper towels. (A stack is kept in the Vending area, however, for employee use.) Instead**

TVA has installed air hand dryers. (\$300/dryer.) This has resulted in a \$2200/year savings plus conserving storage area which is a premium at their buildings. The company investigated composting restroom towels, but discovered that other organics, such as food waste, is needed for cocomposting. Mr. Homa stated that he has heard there is a vendor that will retrieve paper towels for recycling. The company recycles Nos. 1 and 2 plastics. They are looking at the feasibility of recycling their film plastic. Mr. Homa has heard of a company in North Carolina that will take it. The company does not have cafeterias, but where applicable has resorted to installing milk dispensers to eliminate small milk cartons. Magazines, books, and newspapers are recycled as mixed paper. However, TVA is presently renovating their buildings to allow separation of these items. The company is planning on having a separate recycle center downstairs for further separation of commodities. Phone books are given to the Partners in Education program. Funds from the books go toward Special Education programs. In addition, TVA reclaims silver from photograph negatives. TVA recycles its laser printer cartridges. In addition, the vendor that services the copy machines, recycles the toner cartridges. (Although not certain, it is believed these are recharged.) (Note: TVA does not always know how its commodities are recycled. Many of its contracts stipulating recycling, but each vendor is allowed to process these items as he wants.) There is a company in CA (202-489-2550) that will take the 3 1/2 inch computer diskettes that are obsolete or damaged, for recycling. Mr. Homa has heard of a company in Oregon that recycles computers and peripherals. (Note: He receives a lot of information such as this through, the National Recycling Coalition.) Bell Canada has developed a recycling program, which they market.) An additional note: Mr. Homa, Project Manager for Customer Relations, is available for presentations on recycling.

## **RECYCLING PROGRAMS**

### **COMPANY SURVEY**

**Company:** The University of Alabama, Tuscaloosa

**Date:** 02/20/95

**Contact:** William Hoggle (334-348-5950) [114]

**The recycling program at The University of Al, Tuscaloosa involves the following items:**

- **mixed office paper**
- **aluminum cans**
- **newspapers**
- **computer paper**
- **corrugated cardboard**

Information was received describing the recycling program at the university. A university graduate student analyzed the university recycling program in 1993. An update of the data he collected along with program specifics were received from the university and are summarized here. Recycling collections(involving 54 buildings) totaled 186 tons and represented 9.7% of the total campus MSW. Cumulative collections since the beginning of the program in 1990 have totaled 604 tons. Avoided costs to the county incinerator totaled \$3,342 in 1993 and \$10,880 since the program's inception. (Author's Note: This incinerator has since been closed down, per communication with ADEM. [94]) Landfill costs increased from \$18/ton to \$22/ton, in the spring of 1994 indicating the potential for more savings with a reduction in the MSW. There is a downward trend in total solid waste attributed, in part, to source reduction activities. The university is considering expanding the program to the remaining 46 buildings on campus. They are also considering a change from mixed paper to white ledger. White ledger composes 75 percent of the mixed stream and is a higher value commodity. The university introduced recycled letterhead and are involved in testing new container designs as the result of a gift from the AL Soft Drink Association. Scholarships were awarded to two students as a result of the Mountain of Cans competition. This competition collected 2,520 pounds of aluminum cans in 1994.

**Appendix C**  
**Laws and Regulations on Recycling**



Executive Order 12780 of October 31, 1991

**Federal Agency Recycling and the Council on Federal  
Recycling and Procurement Policy**

WHEREAS, this Administration is determined to secure for future generations of Americans their rightful share of our Nation's natural resources, as well as a clean and healthful environment in which to enjoy them; and

WHEREAS, two goals of this Administration's environmental policy, cost-effective pollution prevention and the conservation of natural resources, can be significantly advanced by reducing waste and recycling the resources used by this generation of Americans; and

WHEREAS, the Federal Government, as one of the Nation's largest generators of solid waste, is able through cost-effective waste reduction and recycling resources to conserve local government disposal capacity; and

WHEREAS, the Federal Government, as the Nation's largest single consumer, is able through affirmative procurement practices to encourage the development of economically efficient markets for products manufactured with recycled materials;

NOW, THEREFORE, I, GEORGE BUSH, by the authority vested in me as President by the Constitution and the laws of the United States of America, including the Solid Waste Disposal Act, Public Law 89-272, 79 Stat. 987, as amended by the Resource Conservation and Recovery Act ("RCRA"), Public Law 94-580, 90 Stat. 2795 (1976), hereby order as follows:

**PART 1—PREAMBLE**

Section 101. The purpose of this Executive order is to:

(a) Require that Federal agencies promote cost-effective waste reduction and recycling of reusable materials from wastes generated by Federal Government activities.

(b) Encourage economically efficient market demand for designated items produced using recovered materials by directing the immediate implementation of cost-effective Federal procurement preference programs favoring the purchase of such items.

(c) Provide a forum for the development and study of policy options and procurement practices that will promote environmentally sound and economically efficient waste reduction and recycling of our Nation's resources.

(d) Integrate cost-effective waste reduction and recycling programs into all Federal agency waste management programs in order to assist in addressing the Nation's solid waste disposal problems.

(e) Establish Federal Government leadership in addressing the need for efficient State and local solid waste management through implementation of environmentally sound and economically efficient recycling.

Sec. 102. Consistent with section 6002(c)(1) of RCRA (42 U.S.C. 6962(c)(1)), activities and operations of the executive branch shall be conducted in an environmentally responsible manner, and waste reduction and recycling opportunities shall be utilized to the maximum extent practicable, consistent with economic efficiency.

Sec. 103. Consistent with section 6002(c)(2) of RCRA (42 U.S.C. 6962(c)(2)), agencies that generate energy from fossil fuel in systems that have the technical capacity of using energy or fuels derived from solid waste as a primary or supplementary fuel shall use such capability to the maximum extent practicable.

#### PART 2—DEFINITIONS

For purposes of this order:

Sec. 201. "Federal agency" means any department, agency, or other instrumentality of the executive branch.

Sec. 202. "Procurement" and "acquisition" are used interchangeably to refer to the processes through which Federal agencies purchase products.

Sec. 203. "Recovered materials" is used as defined in section 1004(19) and 6002(h) of the Resource Conservation and Recovery Act (42 U.S.C. 6903(19) and 6962(h)), as amended.

Sec. 204. "Recycling" means the diversion of materials from the solid waste stream and the beneficial use of such materials. Recycling is further defined as the result of a series of activities by which materials that would become or otherwise remain waste, are diverted from the solid waste stream by collection, separation and processing and are used as raw materials in the manufacture of goods sold or distributed in commerce or the reuse of such materials as substitutes for goods made of virgin materials.

Sec. 205. "Waste reduction" means any change in a process, operation, or activity that results in the economically efficient reduction in waste material per unit of production without reducing the value output of the process.

operation, or activity, taking into account the health and environmental consequences of such change.

#### **PART 3—SOLID WASTE RECYCLING PROGRAMS**

**Sec. 301. *Recycling Programs.*** Each Federal agency that has not already done so shall initiate a program to promote cost-effective waste reduction and recycling of reusable materials in all of its operations and facilities. These programs shall foster (a) practices that reduce waste generation, and (b) the recycling of recyclable materials such as paper, plastic, metals, glass, used oil, lead acid batteries, and tires and the composting of organic materials such as yard waste. The recycling programs implemented pursuant to this section must be compatible with applicable State and local recycling requirements.

**Sec. 302. *Contractor Operated Facilities.*** Every contract that provides for contractor operation of a Government-owned or leased facility, awarded more than 210 days after the effective date of this Executive order, shall include provisions that obligate the contractor to comply with the requirements of this Part as fully as though the contractor were a Federal agency.

#### **PART 4—VOLUNTARY STANDARDS**

**Sec. 401. *Amendment of OMB Circular No. A-119.*** The Director of the Office of Management and Budget ("OMB") shall amend, as appropriate, OMB Circular No. A-119, "Federal Participation in the Development and Use of Voluntary Standards," to encourage Federal agencies to participate in the development of environmentally sound and economically efficient standards and to encourage Federal agency use of such standards.

#### **PART 5—PROCUREMENT OF RECOVERED MATERIALS**

**Sec. 501. *Adoption of Affirmative Procurement Programs.*** Within 180 days after the effective date of this order, each Federal agency shall provide a report to the Administrator of the Environmental Protection Agency regarding the Agency's adoption of an affirmative procurement program; such programs are required by section 6002(i) of RCRA (42 U.S.C. 6962(i)). Within 1 year of the issuance of this order, the Administrator of the Environmental Protection Agency shall report to the President regarding the compliance of each Federal agency with this requirement.

**Sec. 502. *Annual Review of Affirmative Procurement Programs.*** In accordance with section 6002(i) of RCRA (42 U.S.C. 6962(i)), each Federal agency shall review annually the effectiveness of its affirmative procurement program and shall provide a report regarding its findings to the Environmental Protection Agency and to the Office of Federal Procurement Policy, beginning with a report covering fiscal year 1992. Such report shall be transmitted by December 15 each year. Reports required by this section shall be made available to the public.

#### **PART 6—RECYCLING COORDINATORS AND THE COUNCIL ON FEDERAL RECYCLING AND PROCUREMENT POLICY**

**Sec. 601. *Federal Recycling Coordinator.*** Within 90 days after the effective date of this order, the Administrator of the Environmental Protection Agency shall designate a senior official of that Agency to serve as the Federal Recycling Coordinator. The Federal Recycling Coordinator shall review and report annually to OMB, at the time of agency budget submissions, the

actions taken by the agencies to comply with the requirements of this order.

**Sec. 602. *Designation of Recycling Coordinators.*** Within 90 days after the effective date of this order, the head of each Federal agency shall designate an agency employee to serve as Agency Recycling Coordinator. The Agency Recycling Coordinator shall be responsible for:

(a) coordinating the development of an effective agency waste reduction and recycling program that complies with the comprehensive implementation plan developed by the Council on Federal Recycling and Procurement Policy;

(b) coordinating agency action to develop benefits, costs, and savings data measuring the effectiveness of the agency program; and

(c) coordinating the development of agency reports required by this Executive order and providing copies of such reports to the Environmental Protection Agency.

**Sec. 603. *The Council on Federal Recycling and Procurement Policy.*** (a) A Council on Federal Recycling and Procurement Policy is hereby established. It shall comprise the Federal Recycling Coordinator, the Chairman of the Council on Environmental Quality, the Administrator of the Office of Federal Procurement Policy, and the Agency Recycling Coordinator and the Procurement Executive of each of the following agencies: the Environmental Protection Agency, the Department of Defense, the General Services Administration, the National Aeronautics and Space Administration, the Department of Energy, the Department of Commerce, and the Department of the Interior. The Federal Recycling Coordinator shall serve as Chair of the Council.

(b) ***Duties.*** The Council on Federal Recycling and Procurement Policy shall:

(1) identify and recommend, to OMB, initiatives that will promote the purposes of this order, including:

(A) the development of appropriate incentives to encourage the economically efficient acquisition by the Federal Government of products that reduce waste and of products produced with recycled materials;

(B) the development of appropriate incentives to encourage active participation in economically efficient Federal waste reduction and recycling programs; and

(C) the development of guidelines for cost-effective waste reduction and recycling activities by Federal agencies;

(2) review Federal agency specifications and standards and recommend changes that will enhance Federal procurement of products made from recycled and recyclable materials, taking into account the costs and the performance requirements of each agency;

(3) collect and disseminate Federal agencies' information concerning methods to reduce wastes, types of materials that can be recycled, the costs and savings associated with recycling, and the current market sources and prices of products that reduce waste and of products produced with recycled materials;

### **Executive Orders**

(4) assist the development of cost-effective waste reduction and recycling programs pursuant to this order by developing guidelines for agency waste reduction and recycling programs and by identifying long-range goals for Federal waste reduction and recycling programs;

(5) provide meaningful data to measure the effectiveness and progress of Federal waste reduction and recycling programs;

(6) provide guidance and assistance to the Agency Recycling Coordinators in setting up and reporting on agency programs; and

(7) review Federal agency compliance with section 103 of this order.

### **PART 7—LIMITATION**

**Sec. 701.** This order is intended only to improve the internal management of the executive branch and shall not be interpreted to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its officers, or any other person.

**Sec. 702.** Section 502 and Part 6 of this order shall be effective for 5 years only, beginning on the effective date of this order.

**Sec. 703.** This order shall be effective immediately.

**GEORGE BUSH**

**Executive Order 12873 of October 20, 1993**

**Federal Acquisition, Recycling, and Waste Prevention**

WHEREAS, the Nation's interest is served when the Federal Government can make more efficient use of natural resources by maximizing recycling and preventing waste wherever possible;

WHEREAS, this Administration is determined to strengthen the role of the Federal Government as an enlightened, environmentally conscious and concerned consumer;

WHEREAS, the Federal Government should—through cost-effective waste prevention and recycling activities—work to conserve disposal capacity, and serve as a model in this regard for private and other public institutions; and

WHEREAS, the use of recycled and environmentally preferable products and services by the Federal Government can spur private sector development of new technologies and use of such products, thereby creating business and employment opportunities and enhancing regional and local economies and the national economy;

NOW, THEREFORE, I, WILLIAM J. CLINTON, by the authority vested in me as President by the Constitution and the laws of the United States of America, including the Solid Waste Disposal Act, Public Law 89-272, 79 Stat. 997, as amended by the Resource Conservation and Recovery Act ("RCRA"), Public Law 94-580, 90 Stat. 2795 as amended (42 U.S.C. 6901-6907), and section 301 of title 3, United States Code, hereby order as follows:

**PART 1—PREAMBLE**

**Section 101.** Consistent with the demands of efficiency and cost effectiveness, the head of each Executive agency shall incorporate waste prevention and recycling in the agency's daily operations and work to increase and expand markets for recovered materials through greater Federal Government preference and demand for such products.

**Sec. 102.** Consistent with policies established by Office of Federal Procurement Policy ("OFPP") Policy Letter 92-4, agencies shall comply with executive branch policies for the acquisition and use of environmentally preferable products and services and implement cost-effective procurement preference programs favoring the purchase of these products and services.

**Sec. 103.** This order creates a Federal Environmental Executive and establishes high-level Environmental Executive positions within each agency to be responsible for expediting the implementation of this order and statutes that pertain to this order.

#### PART 2—DEFINITIONS

For purposes of this order:

**Sec. 201.** "Environmentally preferable" means products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product or service.

**Sec. 202.** "Executive agency" or "agency" means an Executive agency as defined in 5 U.S.C. 105. For the purpose of this order, military departments, as defined in 5 U.S.C. 102, are covered under the auspices of the Department of Defense.

**Sec. 203.** "Postconsumer material" means a material or finished product that has served its intended use and has been discarded for disposal or recovery, having completed its life as a consumer item. "Postconsumer material" is a part of the broader category of "recovered material".

**Sec. 204.** "Acquisition" means the acquiring by contract with appropriated funds for supplies or services (including construction) by and for the use of the Federal Government through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated and evaluated. Acquisition begins at the point when agency needs are established and includes the description of requirements to satisfy agency needs, solicitation and selection of sources, award of contracts, contract financing, contract performance, contract administration and those technical and management functions directly related to the process of fulfilling agency needs by contract.

**Sec. 205.** "Recovered materials" means waste materials and by-products which have been recovered or diverted from solid waste, but such term does not include those materials and by-products generated from, and commonly reused within, an original manufacturing process (42 U.S.C. 8903 (19)).

**Sec. 206.** "Recyclability" means the ability of a product or material to be recovered from, or otherwise diverted from, the solid waste stream for the purpose of recycling.

**Sec. 207.** "Recycling" means the series of activities, including collection, separation, and processing, by which products or other materials are recovered from the solid waste stream for use in the form of raw materials in the manufacture of new products other than fuel for producing heat or power by combustion.

**Sec. 208.** "Waste prevention," also known as "source reduction," means any change in the design, manufacturing, purchase or use of materials or products (including packaging) to reduce their amount or toxicity before they become municipal solid waste. Waste prevention also refers to the reuse of products or materials.

**Sec. 209.** "Waste reduction" means preventing or decreasing the amount of waste being generated through waste prevention, recycling, or purchasing recycled and environmentally preferable products.

**Sec. 210.** "Life Cycle Cost" means the amortized annual cost of a product, including capital costs, installation costs, operating costs, maintenance costs and disposal costs discounted over the lifetime of the product.

**Sec. 211.** "Life Cycle Analysis" means the comprehensive examination of a product's environmental and economic effects throughout its lifetime including new material extraction, transportation, manufacturing, use, and disposal.

**PART 3—THE ROLE OF THE FEDERAL ENVIRONMENTAL EXECUTIVE AND AGENCY ENVIRONMENTAL EXECUTIVES**

**Sec. 301. Federal Environmental Executive.** (a) A Federal Environmental Executive shall be designated by the President and shall be located within the Environmental Protection Agency ("EPA"). The Federal Environmental Executive shall take all actions necessary to ensure that the agencies comply with the requirements of this order and shall generate an annual report to the Office of Management and Budget ("OMB"), at the time of agency budget submissions, on the actions taken by the agencies to comply with the requirements of this order. In carrying out his or her functions, the Federal Environmental Executive shall consult with the Director of the White House Office on Environmental Policy.

(b) *Staffing.* A minimum of four (4) full time staff persons are to be provided by the agencies listed below to assist the Federal Environmental Executive, one of whom shall have experience in specification review and program requirements, one of whom shall have experience in procurement practices, and one of whom shall have experience in solid waste prevention and recycling. These four staff persons shall be appointed and replaced as follows:

(1) a representative from the Department of Defense shall be detailed for not less than one year and no more than two years;

(2) a representative from the General Services Administration ("GSA") shall be detailed for not less than one year and no more than two years;

(3) a representative from EPA shall be detailed for not less than one year and no more than two years; and

(4) a representative from one other agency determined by the Federal Environmental Executive shall be detailed on a rotational basis for not more than one year.



(c) *Administration.* Agencies are requested to make their services, personnel and facilities available to the Federal Environmental Executive to the maximum extent practicable for the performance of functions under this order.

(d) *Committees and Work Groups.* The Federal Environmental Executive shall establish committees and work groups to identify, assess, and recommend actions to be taken to fulfill the goals, responsibilities, and initiatives of the Federal Environmental Executive. As these committees and work groups are created, agencies are requested to designate appropriate personnel in the areas of procurement and acquisition, standards and specifications, electronic commerce, facilities management, waste prevention, and recycling, and others as needed to staff and work on the initiatives of the Executive.

(e) *Duties.* The Federal Environmental Executive, in consultation with the Agency Environmental Executives, shall:

(1) identify and recommend initiatives for government-wide implementation that will promote the purposes of this order, including:

(A) the development of a federal plan for agency implementation of this order and appropriate incentives to encourage the acquisition of recycled and environmentally preferable products by the Federal Government;

(B) the development of a federal implementation plan and guidance for instituting economically efficient federal waste prevention, energy and water efficiency programs, and recycling programs within each agency; and

(C) the development of a plan for making maximum use of available funding assistance programs;

(2) collect and disseminate information electronically concerning methods to reduce waste, materials that can be recycled, costs and savings associated with waste prevention and recycling, and current market sources of products that are environmentally preferable or produced with recovered materials;

(3) provide guidance and assistance to the agencies in setting up and reporting on agency programs and monitoring their effectiveness; and

(4) coordinate appropriate government-wide education and training programs for agencies.

**Sec. 302. Agency Environmental Executives.** Within 90 days after the effective date of this order, the head of each Executive department and major procuring agency shall designate an Agency Environmental Executive from among his or her staff, who serves at a level no lower than at the Deputy Assistant Secretary level or equivalent. The Agency Environmental Executive will be responsible for:

(a) coordinating all environmental programs in the areas of procurement and acquisition, standards and specification review, facilities management, waste prevention and recycling, and logistics;

(b) participating in the interagency development of a Federal plan to:

(1) create an awareness and outreach program for the private sector to facilitate markets for environmentally preferable and recycled products and

services, promote new technologies, improve awareness about federal efforts in this area, and expedite agency efforts to procure new products identified under this order;

(2) establish incentives, provide guidance and coordinate appropriate educational programs for agency employees; and

(3) coordinate the development of standard agency reports required by this order;

(c) reviewing agency programs and acquisitions to ensure compliance with this order.

#### PART 4—ACQUISITION PLANNING AND AFFIRMATIVE PROCUREMENT PROGRAMS

**Sec. 401. Acquisition Planning.** In developing plans, drawings, work statements, specifications, or other product descriptions, agencies shall consider the following factors: elimination of virgin material requirements; use of recovered materials; reuse of product; life cycle cost; recyclability; use of environmentally preferable products; waste prevention (including toxicity reduction or elimination); and ultimate disposal, as appropriate. These factors should be considered in acquisition planning for all procurements and in the evaluation and award of contracts, as appropriate. Program and acquisition managers should take an active role in these activities.

**Sec. 402. Affirmative Procurement Programs.** The head of each Executive agency shall develop and implement affirmative procurement programs in accordance with RCRA section 6002 (42 U.S.C. 6962) and this order. Agencies shall ensure that responsibilities for preparation, implementation and monitoring of affirmative procurement programs are shared between the program personnel and procurement personnel. For the purposes of all purchases made pursuant to this order, EPA, in consultation with such other Federal agencies as appropriate, shall endeavor to maximize environmental benefits, consistent with price, performance and availability considerations, and shall adjust bid solicitation guidelines as necessary in order to accomplish this goal.

(a) Agencies shall establish affirmative procurement programs for all designated EPA guideline items purchased by their agency. For newly designated items, agencies shall revise their internal programs within one year from the date EPA designated the new items.

(b) For the currently designated EPA guideline items, which are: (i) concrete and cement containing fly ash; (ii) recycled paper products; (iii) re-refined lubricating oil; (iv) retread tires; and (v) insulation containing recovered materials; and for all future guideline items, agencies shall ensure that their affirmative procurement programs require that 100 percent of their purchases of products meet or exceed the EPA guideline standards unless written justification is provided that a product is not available competitively within a reasonable time frame, does not meet appropriate performance standards, or is only available at an unreasonable price.

(c) The Agency Environmental Executives will track agencies' purchases of designated EPA guideline items and report agencies' purchases of such guideline items to the Federal Environmental Executive. Agency Environmental Executives will be required to justify to the Federal Environmental Executive as to why the item(s) have not been purchased or submit a plan

for how the agencies intend to increase their purchases of the designated item(s).

(d) Agency affirmative procurement programs, to the maximum extent practicable, shall encourage that:

(1) documents be transferred electronically,

(2) all government documents printed internally be printed double-sided, and

(3) contracts, grants, and cooperative agreements issued after the effective date of this order include provisions that require documents to be printed double-sided on recycled paper meeting or exceeding the standards established in this order or in future EPA guidelines.

**Sec. 403. *Procurement of Existing Guideline Items.*** Within 90 days after the effective date of this order, the head of each Executive agency that has not implemented an affirmative procurement program shall ensure that the affirmative procurement program has been established and is being implemented to the maximum extent practicable.

**Sec. 404. *Electronic Acquisition System.*** To reduce waste by eliminating unnecessary paper transactions in the acquisition process and to foster accurate data collection and reporting of agencies' purchases of recycled content and environmentally preferred products, the executive branch will implement an electronic commerce system consistent with the recommendations adopted as a result of the National Performance Review.

#### **PART 5—STANDARDS, SPECIFICATIONS AND DESIGNATION OF ITEMS**

**Sec. 501. *Specifications, Product Descriptions and Standards.*** Where applicable, Executive agencies shall review and revise federal and military specifications, product descriptions and standards to enhance Federal procurement of products made from recovered materials or that are environmentally preferable. When converting to a Commercial Item Description (CID), agencies shall ensure that environmental factors have been considered and that the CID meets or exceeds the environmentally preferable criteria of the government specification or product description. Agencies shall report annually on their compliance with this section to the Federal Environmental Executive for incorporation into the annual report to OMB referred to in section 301 of this order.

(a) If an inconsistency with RCRA Section 6002 or this order is identified in a specification, standard, or product description, the Federal Environmental Executive shall request that the Environmental Executive of the pertinent agency advise the Federal Environmental Executive as to why the specification cannot be revised or submit a plan for revising it within 60 days.

(b) If an agency is able to revise an inconsistent specification but cannot do so within 60 days, it is the responsibility of that agency's Environmental Executive to monitor and implement the plan for revising it.

**Sec. 502. *Designation of Items that Contain Recovered Materials.*** In order to expedite the process of designating items that are or can be made with recovered materials, EPA shall institute a new process for designating these items in accordance with RCRA section 6002(e) as follows. (a) EPA shall

issue a Comprehensive Procurement Guideline containing designated items that are or can be made with recovered materials.

(1) The proposed guideline shall be published for public comment in the Federal Register within 180 days after the effective date of this order and shall be updated annually after publication for comment to include additional items.

(2) Once items containing recovered materials have been designated by EPA through the new process established pursuant to this section and in compliance with RCRA section 6002, agencies shall modify their affirmative procurement programs to require that, to the maximum extent practicable, their purchases of products meet or exceed the EPA guideline standards unless written justification is provided that a product is not available competitively, not available within a reasonable time frame, does not meet appropriate performance standards, or is only available at an unreasonable price.

(b) Concurrent with the issuance of the Comprehensive Procurement Guideline required by section 502(a) of this order, EPA shall publish for public comment in the Federal Register Recovered Material Advisory Notice(s) that present the range of recovered material content levels within which the designated recycled items are currently available. These levels shall be updated periodically after publication for comment to reflect changes in market conditions.

**Sec. 503. Guidance for Environmentally Preferable Products.** In accordance with this order, EPA shall issue guidance that recommends principles that Executive agencies should use in making determinations for the preference and purchase of environmentally preferable products.

(a) Proposed guidance shall be published for public comment in the Federal Register within 180 days after the effective date of this order, and may be updated after public comment, as necessary, thereafter. To the extent necessary, EPA may issue additional guidance for public comment on how the principles can be applied to specific product categories.

(b) Once final guidance for environmentally preferable products has been issued by EPA, Executive agencies shall use these principles, to the maximum extent practicable, in identifying and purchasing environmentally preferable products and shall modify their procurement programs by reviewing and revising specifications, solicitation procedures, and policies as appropriate.

**Sec. 504. Minimum Content Standard for Printing and Writing Paper.** Executive agency heads shall ensure that agencies shall meet or exceed the following minimum materials content standards when purchasing or causing the purchase of printing and writing paper:

(a) For high speed copier paper, offset paper, forms bond, computer printout paper, carbonless paper, file folders, and white woven envelopes, the minimum content standard shall be no less than 20 percent postconsumer materials beginning December 31, 1994. This minimum content standard shall be increased to 30 percent beginning on December 31, 1998.

(b) For other uncoated printing and writing paper, such as writing and office paper, book paper, cotton fiber paper, and cover stock, the minimum content standard shall be 50 percent recovered materials, including 20 per-

cent postconsumer materials beginning on December 31, 1994. This standard shall be increased to 30 percent beginning on December 31, 1998.

(c) As an alternative to meeting the standards in sections 504(a) and (b), for all printing and writing papers, the minimum content standard shall be no less than 50 percent recovered materials that are a waste material by-product of a finished product other than a paper or textile product which would otherwise be disposed of in a landfill, as determined by the State in which the facility is located.

(1) The decision not to procure recycled content printing and writing paper meeting the standards specified in this section shall be based solely on a determination by the contracting officer that a satisfactory level of competition does not exist, that the items are not available within a reasonable time period, or that the available items fail to meet reasonable performance standards established by the agency or are only available at an unreasonable price.

(2) Each agency should implement waste prevention techniques, as specified in section 402(d) of this order, so that total annual expenditures for recycled content printing and writing paper do not exceed current annual budgets for paper products as measured by average annual expenditures, adjusted for inflation based on the Consumer Price Index or other suitable indices. In determining a target budget for printing and writing paper, agencies may take into account such factors as employee increases or decreases, new agency or statutory initiatives, and episodic or unique requirements (e.g., census).

(3) Effective immediately, all agencies making solicitations for the purchase of printing and writing paper shall seek bids for paper with postconsumer material or recovered waste material as described in section 504(c).

**Sec. 505. Revision of Brightness Specifications and Standards.** The General Services Administration and other Federal agencies are directed to identify, evaluate and revise or eliminate any standards or specifications unrelated to performance that present barriers to the purchase of paper or paper products made by production processes that minimize emissions of harmful by-products. This evaluation shall include a review of unnecessary brightness and stock clause provisions, such as lignin content and chemical pulp requirements. The GSA shall complete the review and revision of such specifications within six months after the effective date of this order, and shall consult closely with the Joint Committee on Printing during such process. The GSA shall also compile any information or market studies that may be necessary to accomplish the objectives of this provision.

**Sec. 506. Procurement of Re-refined Lubricating Oil and Retread Tires.** Within 180 days after the effective date of this order, agencies shall implement the EPA procurement guidelines for re-refined lubricating oil and retread tires.

(a) Commodity managers shall finalize revisions to specifications for re-refined oil and retread tires, and develop and issue specifications for tire retreading services, as commodity managers shall take affirmative steps to procure these items in accordance with RCRA section 6002.

(b) Once these items become available, fleet managers shall take affirmative steps to procure these items in accordance with RCRA section 6002.

**Sec. 507. *Product Testing.*** The Secretary of Commerce, through the National Institute of Standards and Technology ("NIST"), shall establish a program for testing the performance of products containing recovered materials or deemed to be environmentally preferable. NIST shall work with EPA, GSA and other public and private sector organizations that conduct appropriate life cycle analyses to gather information that will assist agencies in making selections of products and services that are environmentally preferable.

(a) NIST shall publish appropriate reports describing testing programs, their results, and recommendations for testing methods and related specifications for use by Executive agencies and other interested parties.

(b) NIST shall coordinate with other Executive and State agencies to avoid duplication with existing testing programs.

#### **PART 6—AGENCY GOALS AND REPORTING REQUIREMENTS**

**Sec. 601. *Goals for Waste Reduction.*** Each agency shall establish a goal for solid waste prevention and a goal for recycling to be achieved by the year 1995. These goals shall be submitted to the Federal Environmental Executive within 180 days after the effective date of this order. Progress on attaining these goals shall be reported by the agencies to the Federal Environmental Executive for the annual report specified in section 301 of this order.

**Sec. 602. *Goal for Increasing the Procurement of Recycled and Other Environmentally Preferable Products.*** Agencies shall strive to increase the procurement of products that are environmentally preferable or that are made with recovered materials and set annual goals to maximize the number of recycled products purchased, relative to non-recycled alternatives.

**Sec. 603. *Review of Implementation.*** The President's Council on Integrity and Efficiency ("PCIE") will request that the Inspectors General periodically review agencies' affirmative procurement programs and reporting procedures to ensure their compliance with this order.

#### **PART 7—APPLICABILITY AND OTHER REQUIREMENTS**

**Sec. 701. *Contractor Operated Facilities.*** Contracts that provide for contractor operation of a government-owned or leased facility, awarded after the effective date of this order, shall include provisions that obligate the contractor to comply with the requirements of this order within the scope of its operations. In addition, to the extent permitted by law and where economically feasible, existing contracts should be modified.

**Sec. 702. *Real Property Acquisition and Management.*** Within 90 days after the effective date of this order, and to the extent permitted by law and where economically feasible, Executive agencies shall ensure compliance with the provisions of this order in the acquisition and management of federally owned and leased space. GSA and other Executive agencies shall also include environmental and recycling provisions in the acquisition of all leased space and in the construction of new federal buildings.

**Sec. 703. *Retention of Funds.*** Within 90 days after the effective date of this order, the Administrator of GSA shall develop a legislative proposal providing authority for Executive agencies to retain a share of the proceeds from the sale of materials recovered through recycling or waste prevention

programs and specifying the eligibility requirements for the materials being recycled.

**Sec. 704. Model Facility Programs.** Each Executive department and major procuring agency shall establish model facility demonstration programs that include comprehensive waste prevention and recycling programs and emphasize the procurement of recycled and environmentally preferable products and services using an electronic data interchange (EDI) system.

**Sec. 705. Recycling Programs.** Each Executive agency that has not already done so shall initiate a program to promote cost effective waste prevention and recycling of reusable materials in all of its facilities. The recycling programs implemented pursuant to this section must be compatible with applicable State and local recycling requirements. Federal agencies shall also consider cooperative ventures with State and local governments to promote recycling and waste reduction in the community.

#### **PART 8—AWARENESS**

**Sec. 801. Agency Awards Program.** A government-wide award will be presented annually by the White House to the best, most innovative program implementing the objectives of this order to give greater visibility to these efforts so that they can be incorporated government-wide.

**Sec. 802. Internal Agency Awards Programs.** Each agency shall develop an internal agency-wide awards program, as appropriate, to reward its most innovative environmental programs. Winners of agency-wide awards will be eligible for the White House award program.

#### **PART 9—REVOCATION, LIMITATION AND IMPLEMENTATION**

**Sec. 901.** Executive Order No. 12780, dated October 31, 1991, is hereby revoked.

**Sec. 902.** This order is intended only to improve the internal management of the executive branch and is not intended to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its agencies, its officers, or any other person.

**Sec. 903.** The policies expressed in this order, including the requirements and elements for effective agency affirmative procurement programs, shall be implemented and incorporated in the Federal Acquisition Regulation (FAR) within 180 days after the effective date of this order. The implementation language shall consist of providing specific direction and guidance on agency programs for preference, promotion, estimation, certification, reviewing and monitoring.

**Sec. 904.** This order shall be effective immediately.

**WILLIAM J. CLINTON**

**THE WHITE HOUSE,  
October 20, 1993.**

**§ 6962. Federal procurement [SWDA  
§ 6002]**

**(a) Application of section**

Except as provided in subsection (b) of this section, a procuring agency shall comply with the requirements set forth in this section and any regulations issued under this section, with respect to any purchase or acquisition of a procurement item where the purchase price of the item exceeds \$10,000 or where the quantity of such items or of functionally equivalent items purchased or acquired in the course of the preceding fiscal year was \$10,000 or more.

**(b) Procurement subject to other law**

Any procurement, by any procuring agency, which is subject to regulations of the Administrator under section 6964 of this title (as promulgated before October 21, 1976, under comparable provisions of prior law) shall not be subject to the requirements of this section to the extent that such requirements are inconsistent with such regulations.

**(c) Requirements**

(1) After the date specified in applicable guidelines prepared pursuant to subsection (e) of this section, each procuring agency which procures any items designated in such guidelines shall procure such items composed of the highest percentage of recovered materials practicable (and in the case of paper, the highest percentage of the postconsumer recovered materials referred to in subsection (h)(1) of this section practicable), consistent with maintaining a satisfactory level of competition, considering such guidelines. The decision not to procure such items shall be based on a determination that such procurement items—



(A) are not reasonably available within a reasonable period of time;

(B) fail to meet the performance standards set forth in the applicable specifications or fail to meet the reasonable performance standards of the procuring agencies; or

(C) are only available at an unreasonable price. Any determination under subparagraph (B) shall be made on the basis of the guidelines of the National Institute of Standards and Technology in any case in which such material is covered by such guidelines.

(2) Agencies that generate heat, mechanical, or electrical energy from fossil fuel in systems that have the technical capability of using energy or fuels derived from solid waste as a primary or supplementary fuel shall use such capability to the maximum extent practicable.

(3) After the date specified in any applicable guidelines prepared pursuant to subsection (e) of this section, contracting officers shall require that vendors:

(A) certify that the percentage of recovered materials to be used in the performance of the contract will be at least the amount required by applicable specifications or other contractual requirements, and

(B) estimate the percentage of the total material utilized for the performance of the contract which is recovered materials.

**(d) Specifications**

All Federal agencies that have the responsibility for drafting or reviewing specifications for procurement items procured by Federal agencies shall—

(1) as expeditiously as possible but in any event no later than eighteen months after November 8, 1984, eliminate from such specifications—

(A) any exclusion of recovered materials and

(B) any requirement that items be manufactured from virgin materials; and

(2) within one year after the date of publication of applicable guidelines under subsection (e) of this section, or as otherwise specified in such guidelines, assure that such specifications require the use of recovered materials to the maximum extent possible without jeopardizing the intended end use of the item.

**(e) Guidelines**

The Administrator, after consultation with the Administrator of General Services, the Secretary of

Commerce (acting through the National Institute of Standards and Technology), and the Public Printer, shall prepare, and from time to time revise, guidelines for the use of procuring agencies in complying with the requirements of this section. Such guidelines shall—

(1) designate those items which are or can be produced with recovered materials and whose procurement by procuring agencies will carry out the objectives of this section, and in the case of paper, provide for maximizing the use of post consumer recovered materials referred to in subsection (h)(1) of this section;

(2) set forth recommended practices with respect to the procurement of recovered materials and items containing such materials and with respect to certification by vendors of the percentage of recovered materials used,

and shall provide information as to the availability, relative price, and performance of such materials and items and where appropriate shall recommend the level of recovered material to be contained in the procured product. The Administrator shall prepare final guidelines for paper within one hundred and eighty days after November 8, 1984, and for three additional product categories (including tires) by October 1, 1985. In making the designation under paragraph (1), the Administrator shall consider, but is not limited in his considerations, to—

(A) the availability of such items;

(B) the impact of the procurement of such items by procuring agencies on the volume of solid waste which must be treated, stored or disposed of;

(C) the economic and technological feasibility of producing and using such items; and

(D) other uses for such recovered materials.

**(f) Procurement of services**

A procuring agency shall, to the maximum extent practicable, manage or arrange for the procurement of solid waste management services in a manner which maximizes energy and resource recovery.

**(g) Executive Office**

The Office of Procurement Policy in the Executive Office of the President, in cooperation with the Administrator, shall implement the requirements of this section. It shall be the responsibility of the Office of Procurement Policy to coordinate this policy with other policies for Federal procurement, in such a way as to maximize the use of recovered resources, and to, every two years beginning in

1984, report to the Congress on actions taken by Federal agencies and the progress made in the implementation of this section, including agency compliance with subsection (d) of this section.

**(h) Definitions**

As used in this section, in the case of paper products, the term "recovered materials" includes—

**(1) postconsumer materials such as—**

**(A)** paper, paperboard, and fibrous wastes from retail stores, office buildings, homes, and so forth, after they have passed through their end-usage as a consumer item, including: used corrugated boxes; old newspapers; old magazines; mixed waste paper; tabulating cards; and used cordage; and

**(B)** all paper, paperboard, and fibrous wastes that enter and are collected from municipal solid waste, and

**(2) manufacturing, forest residues, and other wastes such as—**

**(A)** dry paper and paperboard waste generated after completion of the papermaking process (that is, those manufacturing operations up to and including the cutting and trimming of the paper machine reel into smaller rolls or rough sheets) including: envelope cuttings, bindery trimmings, and other paper and paperboard waste, resulting from printing, cutting, forming, and other converting operations; bag, box, and carton manufacturing wastes; and butt rolls, mill wrappers, and rejected unused stock; and

**(B)** finished paper and paperboard from obsolete inventories of paper and paperboard manufacturers, merchants, wholesalers, dealers, printers, converters, or others;

**(C)** fibrous byproducts of harvesting, manufacturing, extractive, or wood-cutting processes, flax, straw, linters, bagasse, slash, and other forest residues;

**(D)** wastes generated by the conversion of goods made from fibrous material (that is, waste rope from cordage manufacture, textile mill waste, and cuttings); and

**(E)** fibers recovered from waste water which otherwise would enter the waste stream.

**(i) Procurement program**

**(1)** Within one year after the date of publication of applicable guidelines under subsection (e) of this section, each procuring agency shall develop an affirmative procurement program which will assure

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that items composed of recovered materials will be purchased to the maximum extent practicable and which is consistent with applicable provisions of Federal procurement law.

**(2)** Each affirmative procurement program required under this subsection shall, at a minimum, contain—

**(A)** a recovered materials preference program;

**(B)** an agency promotion program to promote the preference program adopted under subparagraph (A);

**(C)** a program for requiring estimates of the total percentage of recovered material utilized in the performance of a contract; certification of minimum recovered material content actually utilized, where appropriate; and reasonable verification procedures for estimates and certifications; and

**(D)** annual review and monitoring of the effectiveness of an agency's affirmative procurement program.

In the case of paper, the recovered materials preference program required under subparagraph (A) shall provide for the maximum use of the post consumer recovered materials referred to in subsection (h)(1) of this section.

**(3)** In developing the preference program, the following options shall be considered for adoption:

**(A) Case-by-Case Policy Development:** Subject to the limitations of subsection (c)(1)(A) through (C) of this section, a policy of awarding contracts to the vendor offering an item composed of the highest percentage of recovered materials practicable (and in the case of paper, the highest percentage of the post consumer recovered materials referred to in subsection (h)(1) of this section). Subject to such limitations, agencies may make an award to a vendor offering items with less than the maximum recovered materials content.

**(B) Minimum Content Standards:** Minimum recovered materials content specifications which are set in such a way as to assure that the recovered materials content (and in the case of paper, the content of post consumer materials referred to in subsection (h)(1) of this section) required is the maximum available without jeopardizing the intended end use of the item, or violating the limitations of subsection (c)(1)(A) through (C) of this section.

Procuring agencies shall adopt one of the options set forth in subparagraphs (A) and (B) or a substantially equivalent alternative, for inclusion in the affirmative procurement program.

## PART 246—SOURCE SEPARATION FOR MATERIALS RECOVERY GUIDELINES

### Subpart A—General Provisions

- Sec.  
246.100 Scope.  
246.101 Definitions.

### Subpart B—Requirements and Recommended Procedures

- 246.200 High-grade paper recovery.  
246.200-1 Requirements.  
246.200-2 Recommended procedures: High-grade paper recovery from smaller offices.  
246.200-3 Recommended procedures: Market study.  
246.200-4 Recommended procedures: Levels of separation.  
246.200-5 Recommended procedures: Methods of separation and collection.  
246.200-6 Recommended procedures: Storage.  
246.200-7 Recommended procedures: Transportation.  
246.200-8 Recommended procedures: Cost analysis.  
246.200-9 Recommended procedures: Contracts.

- 246.200-10 Recommended procedures: Public information and education.  
246.201 Residential materials recovery.  
246.201-1 Requirement.  
246.201-2 Recommended procedures: Newspaper recovery from smaller residential facilities.  
246.201-3 Recommended procedures: Glass, can, and mixed paper separation.  
246.201-4 Recommended procedures: Market study.  
246.201-5 Recommended procedures: Methods of separation and collection.  
246.201-6 Recommended procedures: Transportation to market.  
246.201-7 Recommended procedures: Cost analysis.  
246.201-8 Recommended procedures: Contracts.  
246.201-9 Recommended procedures: Public information and education.  
246.202 Corrugated container recovery.  
246.202-1 Requirement.  
246.202-2 Recommended procedures: Corrugated container recovery from smaller commercial facilities.  
246.202-3 Recommended procedures: Market study.  
246.202-4 Recommended procedures: Methods of separation and storage.  
246.202-5 Recommended procedures: Transportation.  
246.202-6 Recommended procedures: Cost analysis.  
246.202-7 Recommended procedures: Establishment of purchase contract.  
246.203 Reevaluation.

### APPENDIX TO PART 246—RECOMMENDED BIBLIOGRAPHY

AUTHORITY: Secs. 1008 and 6004 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6907, 6964).

SOURCE: 41 FR 16962, Apr. 23, 1976, unless otherwise noted.

### Subpart A—General Provisions

#### § 246.100 Scope.

(a) These guidelines are applicable to the source separation of residential, commercial, and institutional solid wastes. Explicitly excluded are mining, agricultural, and industrial solid wastes; hazardous wastes; sludges; construction and demolition wastes; infectious wastes; classified waste.

(b) The "Requirement" sections contained herein delineate minimum actions for Federal agencies for the recovery of resources from solid waste through source separation. Pursuant to section 211 of the Solid Waste Disposal

Act, as amended, and Executive Order 11752 section 4(a), the "Requirement" sections of these guidelines are mandatory for all Federal agencies that generate solid waste. In addition, they are recommended to State, interstate, regional, and local governments for use in their activities.

(c) The "Recommended Procedures" sections are presented to suggest actions or preferred methods by which the objectives of the requirements can be realized. The "Recommended Procedures" are not mandatory for Federal agencies.

(d) The Environmental Protection Agency will render technical assistance in the form of sample cost analysis formats, sample bid specifications, implementation guidance documents and other guidance to Federal agencies when requested to do so, pursuant to section 3(d)1 of Executive Order 11752.

(e) Within one year after the effective date of these guidelines, agencies shall make a final determination as to what actions shall be taken to adopt the requirements of these guidelines and shall, within two months of such determination, submit to the Administrator a schedule of such actions.

(f) Federal agencies that make the determination not to source separate as described in §§ 246.200-1, 246.201-1, and 246.202-1, for whatever reason, shall make available to the Administrator the analysis and rationale used in making that determination. The Administrator shall publish notice of the availability of this report to the general public in the FEDERAL REGISTER. The following are considered to be valid reasons for not source separating under individual facts and circumstances: inability to sell the recovered materials due to lack of market, and costs so unreasonably high as to render source separation for materials recovery economically impracticable.

(1) The following points are to be covered in the report:

(i) A description of alternative actions considered with emphasis on those alternatives which involve source separation for materials recovery.

(ii) A description of ongoing actions which will be continued and new actions taken or proposed. This statement should identify all agency facilities

which will be affected by these actions including a brief description of how such facilities will be affected.

(iii) An analysis in support of the action chosen by the agency including technical data, market studies, and policy considerations used in arriving at such a determination.

In covering the points above, agencies should make every effort to present information succinctly in a form easily understood, but in sufficient detail so that the factors influencing the decision not to source separate for materials recovery are clear.

(2) The above report shall be submitted to the Administrator as soon as possible after a final agency determination has been made not to adopt the requirements of these guidelines, but in no case later than sixty days after such final determination. The Administrator will indicate to the agency his concurrence/nonconcurrence with the agency's decision, including his reason therefor.

(3) Implementation of actions that would preclude source separation for materials recovery shall be deferred, for sixty days where feasible, in order to give the Administrator an opportunity to receive, analyze and seek clarification of the above required report.

(4) It is recommended that where the report required by § 246.100(f) concerns an action for which an Environmental Impact Statement (EIS) is required by the National Environmental Policy Act, that the report be circulated together with the EIS.

(g) The report required under § 246.100(e) and (f) shall be made on forms to be prescribed by the Administrator by notice in the FEDERAL REGISTER.

[41 FR 18952, Apr. 23, 1976, as amended at 47 FR 36603, Aug. 20, 1982]

#### § 246.101 Definitions.

As used in these guidelines:

(a) *Agricultural solid waste* means the solid waste that is generated by the rearing of animals, and the producing and harvesting of crops or trees.

(b) *Baler* means a machine used to compress solid wastes, primary materials, or recoverable materials, with or

without binding, to a density or from which will support handling and transportation as a material unit rather than requiring a disposable or reuseable container. This specifically excludes briquetters and stationary compaction equipment which is used to compact materials into disposable or reuseable containers.

(c) *Bulk container* means a large container that can either be pulled or lifted mechanically onto a service vehicle or emptied mechanically into a service vehicle.

(d) *Classified Waste* means waste material that has been given security classification in accordance with 50 U.S.C. 401 and Executive Order 11652.

(e) *Collection* means the act of removing solid waste (or materials which have been separated for the purpose of recycling) from a central storage point.

(f) *Commercial establishment* means stores, offices, restaurants, warehouses and other non-manufacturing activities.

(g) *Commercial solid waste* means all types of solid wastes generated by stores, offices, restaurants, warehouses and other non-manufacturing activities, and non-processing wastes such as office and packing wastes generated at industrial facilities.

(h) *Construction and demolition waste* means the waste building materials, packaging, and rubble resulting from construction, remodeling, repair, and demolition operations on pavements, houses, commercial buildings and other structures.

(i) *Compartmentalized vehicle* means a collection vehicle which has two or more compartments for placement of solid wastes or recyclable materials. The compartments may be within the main truck body or on the outside of that body as in the form of metal racks.

(j) *Corrugated container waste* means discarded corrugated boxes.

(k) *Corrugated box* means a container for goods which is composed of an inner fluting of material (corrugating medium) and one or two outer liners of material (linerboard).

(l) *Federal facility* means any building, installation, structure, land, or public work owned by or leased to the Federal Government. Ships at sea, air-

craft in the air, land forces on maneuvers, and other mobile facilities are not considered Federal facilities for the purpose of these guidelines. United States Government installations located on foreign soil or on land outside the jurisdiction of the United States Government are not considered Federal facilities for the purpose of these guidelines.

(m) *Food waste* means the organic residues generated by the handling, storage, sale, preparation, cooking, and serving of foods; commonly called garbage.

(n) *Generation* means the act or process of producing solid waste.

(o) *High-grade paper* means letterhead, dry copy papers, miscellaneous business forms, stationery, typing paper, tablet sheets, and computer printout paper and cards, commonly sold as "white ledger," "computer printout" and "tab card" grade by the wastepaper industry.

(p) *Industrial solid waste* means the solid waste generated by industrial processes and manufacturing.

(q) *Infectious waste* means: (1) Equipment, instruments, utensils, and fomites (any substance that may harbor or transmit pathogenic organisms) of a disposable nature from the rooms of patients who are suspected to have or have been diagnosed as having a communicable disease and must, therefore, be isolated as required by public health agencies; (2) laboratory wastes, such as pathological specimens (e.g. all tissues, specimens of blood elements, excreta, and secretions obtained from patients or laboratory animals) and disposable fomites attendant thereto; (3) surgical operating room pathologic specimens and disposable fomites attendant thereto and similar disposable materials from outpatient areas and emergency rooms.

(r) *Institutional solid waste* means solid wastes generated by educational, health care, correctional and other institutional facilities.

(s) *Mining wastes* means residues which result from the extraction of raw materials from the earth.

(t) *Post-consumer waste (PCW)* means a material or product that has served its intended use and has been discarded

for disposal or recovery after passing through the hands of a final consumer.

(u) *Recoverable resources* means materials that still have useful physical, chemical, or biological properties after serving their original purpose and can, therefore, be reused or recycled for the same or other purposes.

(v) *Recovery* means the process of obtaining materials or energy resources from solid waste.

(w) *Recycled material* means a material that is used in place of a primary, raw or virgin material in manufacturing a product.

(x) *Recycling* means the process by which recovered materials are transformed into new products.

(y) *Residential solid waste* means the wastes generated by the normal activities of households, including but not limited to, food wastes, rubbish, ashes, and bulky wastes.

(z) *Separate collection* means collecting recyclable materials which have been separated at the point of generation and keeping those materials separate from other collected solid waste in separate compartments of a single collection vehicle or through the use of separate collection vehicles.

(aa) *Sludge* means the accumulated semiliquid suspension of settled solids deposited from wastewaters or other fluids in tanks or basins. It does not include solid or dissolved material in domestic sewage or other significant pollutants in water resources, such as silt, dissolved material in irrigation return flows or other common water pollutants.

(bb) *Solid waste* means garbage, refuse, sludge, and other discarded solid materials, including solid waste materials resulting from industrial, commercial, and agricultural operations, and from community activities, but does not include solids or dissolved materials in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial wastewater effluents, dissolved materials in irrigation return flows or other common water pollutants. Unless specifically noted otherwise, the term "solid waste" as used in these guidelines shall not include mining, agricultural, and industrial solid wastes; hazardous

wastes; sludges; construction and demolition wastes; and infectious wastes.

(cc) *Source separation* means the setting aside of recyclable materials at their point of generation by the generator.

(dd) *Specification* means a clear and accurate description of the technical requirements for materials, products or services, identifying the minimum requirements for quality and construction of materials and equipment necessary for an acceptable product. In general, specifications are in the form of written descriptions, drawings, prints, commercial designations, industry standards, and other descriptive references.

(ee) *Stationary compactor* means a powered machine which is designed to compact solid waste or recyclable materials, and which remains stationary when in operation.

(ff) *Storage* means the interim containment of solid waste after generation and prior to collection for ultimate recovery or disposal.

(gg) *Virgin material* means a raw material used in manufacturing that has been mined or harvested and has not as yet become a product.

### Subpart B—Requirements and Recommended Procedures

#### § 246.200 High-grade paper recovery.

##### § 246.200-1 Requirements.

High-grade paper generated by office facilities of over 100 office workers shall be separated at the source of generation, separately collected, and sold for the purpose of recycling.

##### § 246.200-2 Recommended procedures: High-grade paper recovery from smaller offices.

The recovery of high-grade paper generated by office facilities of less than 100 office workers should be investigated in conformance with the following recommended procedures and implemented where feasible.

##### § 246.200-3 Recommended procedures: Market study.

An investigation of markets should be made by the organization respon-

sible for the sale of recyclable materials in each Federal agency and should include at a minimum:

(a) Identifying potential purchasers of the recovered paper through standard market research techniques;

(b) Directly contacting buyers, and determining the buyers' quality specifications, the exact types of paper to be recycled, potential transportation agreements and any minimum quantity criteria; and

(c) Determining the price that the buyer will pay for the recovered paper and the willingness of the buyer to sign a contract for purchase of the paper at a guaranteed minimum price.

**§ 246.200-4 Recommended procedures: Levels of separation.**

A two-level separation is recommended for most facilities. This separation should consist of (a) high-grade wastepaper and (b) all other waste. Facilities that produce large enough quantities of waste computer paper and cards to make their separation into a separate category cost effective may choose to implement three levels of separation: (1) Computer papers, (2) other high-grade papers, (3) all other wastes.

**§ 246.200-5 Recommended procedures: Methods of separation and collection.**

(a) Systems designed to recover high grades of office paper at the source of generation, i.e., the desk, are the desktop system, the two-wastebasket system, and the office centralized container system.

(b) With the desk-top system, recyclable paper is placed by the generator in a container on his desk, while other waste is placed in a wastebasket. With the two-wastebasket system, recyclable paper is placed by the generator in one desk-side wastebasket, and all other waste is placed in another. In the centralized-container system, large containers for the collection of recyclables are placed in centralized locations within the office areas of the building. Nonrecyclable waste is placed in desk-side wastebaskets.

(c) The recommended system is the desk-top system because it is designed

to maximize recovery of high value material in an economically feasible manner. While the two-wastebasket system and centralized container system have been implemented with success in isolated instances, data indicate that, on the whole, these systems have experienced high levels of contamination, low levels of participation, and low revenues. The desk-top system has been designed to minimize these problems.

(d) The precise method of separation and collection used to implement the desk-top system will depend upon such things as the physical layout of the individual facility, the ease of collection, and the projected cost effectiveness of using various methods. The recommended desk-top system is carried out in the following manner:

(1) Workers are to deposit high-grade paper into a desk-top tray or other small desk-top holder to be supplied by the agency. This holder should be designed in such a way as to prevent it holding contaminants, such as food or beverage containers.

(2) At the office worker's convenience or when the tray is filled, the worker carries the paper to a conveniently located bulk container within the office area. This large container should be located in an area the worker frequents in the normal course of business.

(3) In locations where computer cards and printouts are to be collected separately, the receptacle for these wastes should be near the computer terminal or in some other logical, centrally located place.

(4) Collection of the high-grade paper from the bulk containers in the office area should be performed by the janitorial or general maintenance service.

The number of locations and the frequency of collection of these containers will be determined by office size and maintenance staff capacity.

(e) Mixed paper and some high-grade office papers have also been recovered for recycling by hand-picking in an individual building's trash room or at a centralized facility serving several buildings. With these hand-picking systems, recyclable waste is not separated at the source of generation, but is mixed with other waste in the usual manner and removed to a centralized

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location where recyclable paper is picked out of the mixed waste by hand. Facilities may choose to use this method of high-grade paper recovery if it is shown by analysis to be economically preferable to source separation.

### **§ 246.200-6 Recommended procedures: Storage.**

Among the alternatives for paper storage are on-site bailing, the use of stationary compactors, or storage in corrugated boxes or normal waste containers. Stored paper should be protected from fire, inclement weather, theft, and vandalism.

### **§ 246.200-7 Recommended procedures: Transportation.**

Transportation to market may be supplied by the facility, by a private hauler, or by the purchaser. Collection of the recyclable paper should be on a regular, established schedule.

### **§ 246.200-8 Recommended procedures: Cost analysis.**

After potential markets have been located (but prior to initiation of formal bidding procedures), preliminary determinations of various separation methods, storage, and transportation costs have been made, and estimated tonnages of both recoverable high-grade paper and residual solid waste have been established, an analysis should be conducted which compares the costs of the present waste collection and disposal system with the proposed segregated systems. At a minimum, the study should include all capital, operating and overhead costs and take into account credits for revenue from paper sales and savings from diverting recycled materials from disposal. Potential costs to upgrade collection and disposal practices to comply with EPA's Guidelines for the Storage and Collection of Residential, Commercial and Institutional Solid Wastes (40 CFR part 243) and Thermal Processing and Land Disposal Guidelines (40 CFR parts 240 and 241) should be included in the analysis. In formulating a separation system and evaluating its costs, every effort should be made to use janitorial and waste collection resources efficiently. This cost analysis should en-

able the facility to determine the most cost effective method of implementing the requirement of this part.

### **§ 246.200-9 Recommended procedures: Contracts.**

Formal bids should be requested for purchase of the recovered materials, such bids being solicited in conformance with bidding procedures established for the responsible agency. Contracts should include the buyer's quality specifications, quantity and transportation agreements, a guarantee that the material will be accepted for one year or more, and a guaranteed minimum purchase price.

### **§ 246.200-10 Recommended procedures: Public information and education.**

A well-organized and well-executed public information and education program explaining the justification, goals, methods and level of separation should be conducted to inform and motivate office personnel and secure their cooperation in separating their waste. This public information and education program should precede the program and continue on a regular basis for its duration.

### **§ 246.201 Residential materials recovery.**

#### **§ 246.201-1 Requirement.**

Separation of used newspapers at the source of residential generation in conjunction with separate collection shall be carried out at all facilities in which more than 500 families reside, and the newspapers shall be sold for the purpose of recycling.

#### **§ 246.201-2 Recommended procedures: Newsprint recovery from smaller residential facilities.**

The recovery of newsprint generated by residential facilities of less than 500 families should be investigated in conformance with the following recommended procedures and implemented where feasible.



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### **§ 246.201-3 Recommended procedures: Glass, can, and mixed paper separation.**

In areas where markets are available, it is recommended that glass, cans, and mixed paper be separated at the source of generation and separately collected for the purpose of recycling.

### **§ 246.201-4 Recommended procedures: Market study.**

An investigation of markets should be made for each material by the organization responsible for sale of recyclable materials in each agency and should include at a minimum:

(a) Identifying potential purchasers of the recovered material through standard market research techniques.

(b) Directly contacting buyers and determining the buyers' quality specifications, potential transportation agreements and any minimum quantity criteria.

(c) Determining the prices that the buyer will pay for the recovered material and the willingness of the buyer to sign a contract for the purchase of the material at guaranteed minimum prices.

### **§ 246.201-5 Recommended procedures: Methods of separation and collection.**

Following separation within the home, any of the following methods of collection may be used:

(a) Materials may be placed at the curbside by the resident and may be collected from each household using separate trucks or compartmentalized vehicles.

(b) For multi-family dwellings, separated materials may be placed in bulk containers located outside of the building and collected by trucks dispatched to collect recyclables.

(c) Collection stations may be set up at convenient locations to which residents bring recyclables. These stations should provide separate bulk containers for each item to be recycled. The size and type of container will depend on the volume and type of material collected, the method of transportation to be used in hauling the materials to market and the frequency of removal.

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### **§ 246.201-6 Recommended procedures: Transportation to market.**

Transportation to market may be supplied by the facility or the community generating the waste, by a private hauler, or by the purchaser.

### **§ 246.201-7 Recommended procedures: Cost analysis.**

After potential markets have been located (but prior to initiation of formal bidding procedures), preliminary determinations of various separation methods, storage and transportation costs have been made, and estimated tonnages of both recoverable materials and residual solid waste have been established, an analysis should be conducted which compares the costs of the present waste collection and disposal system with the proposed segregated systems. At a minimum this study should include all capital, operating and overhead costs and take into account credits for revenue from paper sales and savings from diverting recycled materials from disposal. Potential costs to upgrade collection and disposal practices to comply with EPA's Guidelines for the Storage and Collection of Residential, Commercial and Institutional Solid Wastes (40 CFR part 243) and Thermal Processing and Land Disposal Guidelines (40 CFR parts 240 and 241) should be included in the analysis. In formulating a separate collection system and evaluating its costs, every effort should be made to use idle equipment and underutilized collection manpower to reduce separate collection costs. This cost analysis should enable the facility to determine the most cost effective method if implementing the requirements of this part.

### **§ 246.201-8 Recommended procedures: Contracts.**

Formal bids should be requested for purchase of the recovered materials, such bids being solicited in conformance with bidding procedures established for the responsible jurisdiction. Contracts should include the buyer's quality specifications, quantity and transportation agreements, a guarantee that the material will be accepted for one year or more and a guaranteed minimum purchase price.

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### § 246.201-9 Recommended procedures: Public information and education.

A well organized and well executed public information and education program explaining the justification, goals, methods and level of separation should be conducted to inform and motivate householders and to secure their cooperation in separating their waste. This public information and education program should precede the program and continue on a regular basis for its duration.

### § 246.202 Corrugated container recovery.

#### § 246.202-1 Requirement.

Any commercial establishment generating 10 or more tons of waste corrugated containers per month shall separately collect and sell this material for the purpose of recycling.

#### § 246.202-2 Recommended procedures: Corrugated container recovery from smaller commercial facilities.

The recovery of corrugated containers from commercial facilities generating less than 10 tons per month should be investigated in conformance with the following recommended procedures and implemented where feasible.

#### § 246.202-3 Recommended procedures: Market study.

An investigation of markets should be made by the organization responsible for sale of recyclable material in each Federal agency and should include at a minimum:

(a) Identifying potential purchasers of the recovered corrugated through standard market research techniques.

(b) Directly contacting buyers and determining the buyers' quality specifications, potential transportation agreements and any minimum quantity criteria.

(c) Determining the price that the buyer will pay for the recovered corrugated and the willingness of the buyer to sign a contract for purchase of the paper at a guaranteed minimum price.

### § 246.202-4 Recommended procedures: Methods of separation and storage.

The method selected will depend upon such variables as the physical layout of the individual generating facility, the rate at which the corrugated accumulates, the storage capacity of the facility, and the projected cost-effectiveness of using the various methods. All of the following suggested modes of separation and storage presuppose that the corrugated boxes will be accumulated at a central location in the facility after their contents are removed and that the boxes are flattened.

(a) Balers of various sizes: Corrugated boxes are placed in balers and compacted into bales. These bales may be stored inside or outside of the facility. The bales should be protected from fire, inclement weather, theft, and vandalism.

(b) Stationary compactors or bulk containers: Corrugated boxes are placed in a stationary compactor or bulk containers outside of the facility. The containers should be protected from fire, inclement weather, theft and vandalism.

### § 246.202-5 Recommended procedures: Transportation.

Transportation to market may be supplied by either the facility, a private hauler or the purchaser. In facilities to which goods are delivered from a central warehouse, corrugated may be backhauled by delivery trucks to the central facility and baled there for delivery to a user.

### § 246.202-6 Recommended procedures: Cost analysis.

After potential markets have been identified (but prior to initiation of formal bidding), preliminary determinations of various separation methods, storage and transportation costs have been made, and estimated tonnages of both recoverable material and residual solid waste have been established, an analysis should be conducted which compares the costs of the present waste collection and disposal system with the proposed segregated systems. At a minimum, the study should include all capital, operating

and overhead costs and take into account credits for revenue from paper sales and savings from diverting recycled materials from disposal. Potential costs to upgrade collection and disposal practices to comply with EPA's Guidelines for the Storage and Collection of Residential, Commercial and Institutional Solid Wastes (40 CFR part 243) and Thermal Processing and Land Disposal Guidelines (40 CFR parts 240 and 241) should be included in the analysis. This cost analysis should enable the facility to determine the most cost effective method of implementing these guidelines.

**§ 246.202-7 Recommended procedures: Establishment of purchase contract.**

Formal bids should be requested for purchase of the recovered materials, such bids being solicited in conformance with bidding procedures established for the responsible agency. Contracts should include the buyer's quality specifications, transportation agreements, a guarantee that the material will be accepted for one year or more and a guaranteed minimum purchase price.

**§ 246.203 Reevaluation.**

**APPENDIX TO PART 246—RECOMMENDED BIBLIOGRAPHY**

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**Appendix D**  
**Photographs**

## **Appendix D**

### **Photographs**

1. MDI refuse bin located on south side of Building 4471 indicating poor condition of many of the bins: dents, rusted out around bottom.
2. "Saw dust only" bin located on south side of Building 4471 indicating the presence of nonsawdust items. A special lid constructed over the top of the bin may eliminate this problem.

#### **Photographs 3 - 8: Huntsville Recycled Fiber Processing Center**

3. Front entrance.
4. Truck scale. Also used by individuals dropping off recyclables in personal cars.
5. Interior showing baler with conveyor.
6. Interior showing stacked bales of paper.
7. Bales stacked on exterior asphalt pad.
8. Trucks delivery recyclables subsequent to being weighed. Once recyclables are unloaded, the trucks are weighed for a second time.

#### **Photographs 9 - 14: BFI Processing Center**

9. Exterior of building showing front offices and front-end loader.
10. Three-sided canopy showing loose cardboard waiting to be baled.
11. Canopy for processing aluminum cans.
12. Exterior asphalt pad showing roll-off bins, trucks, and stockpiling of loose commodities.
13. Commingled commodities.
14. Drop-off containers.



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